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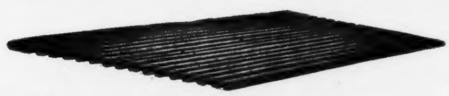

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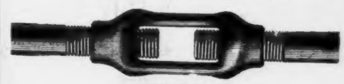

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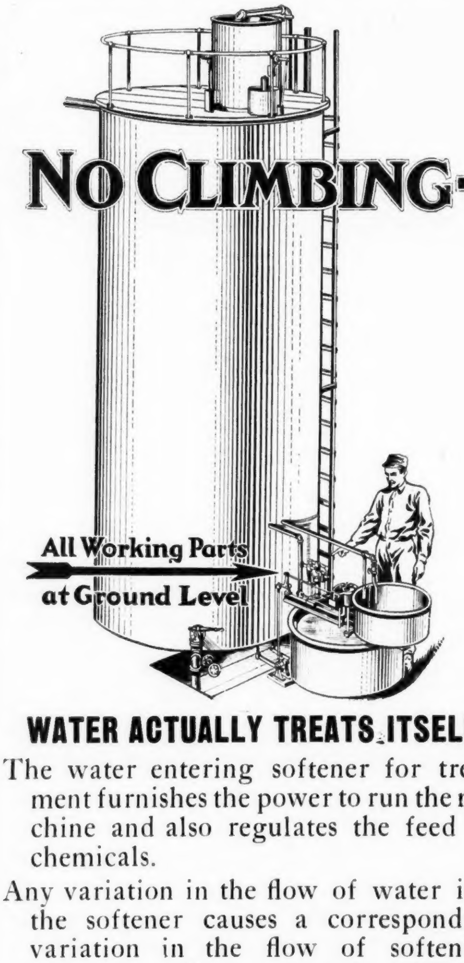

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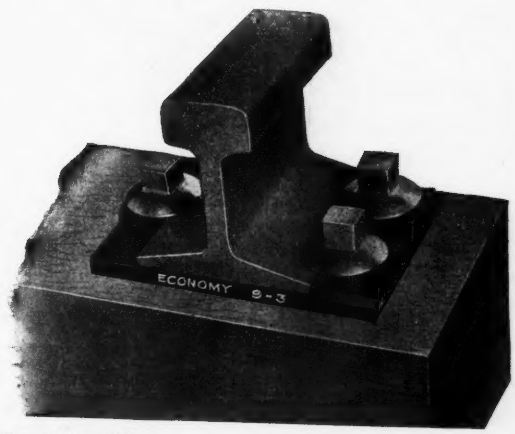

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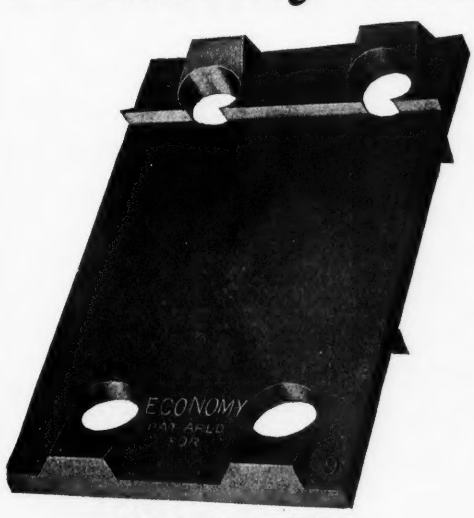

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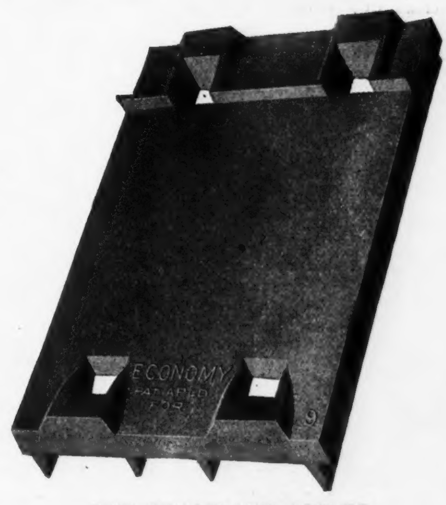

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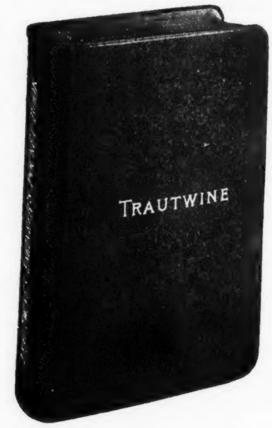

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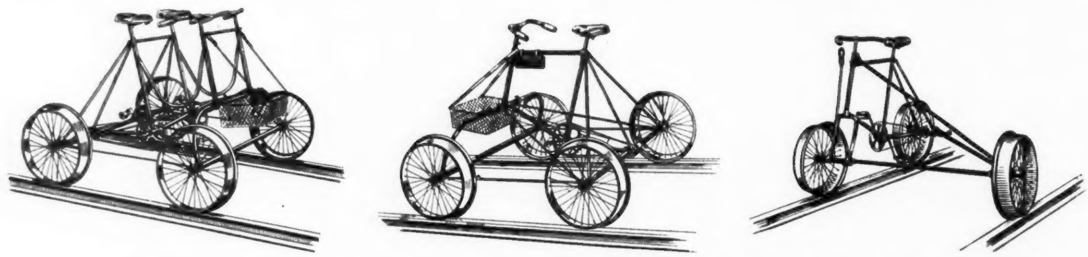

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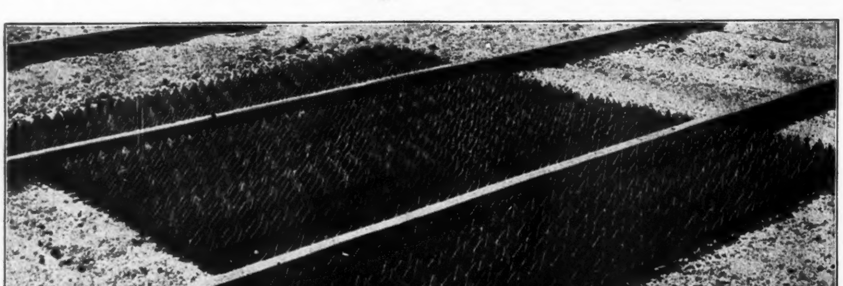

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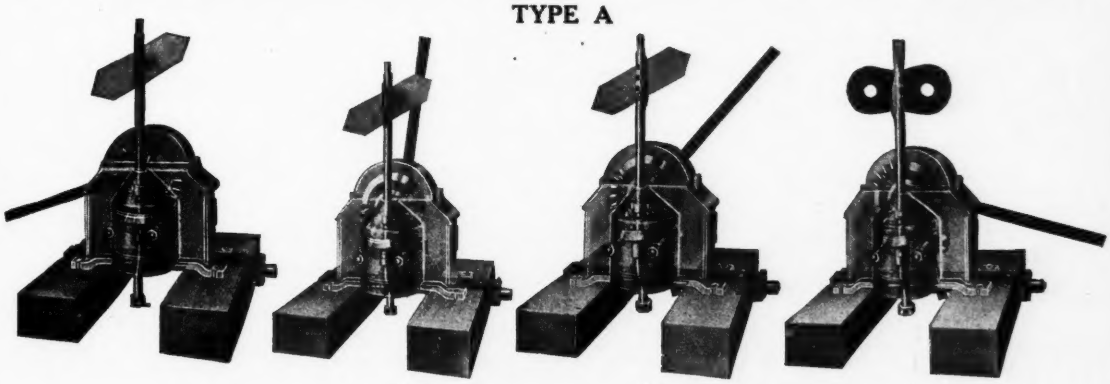

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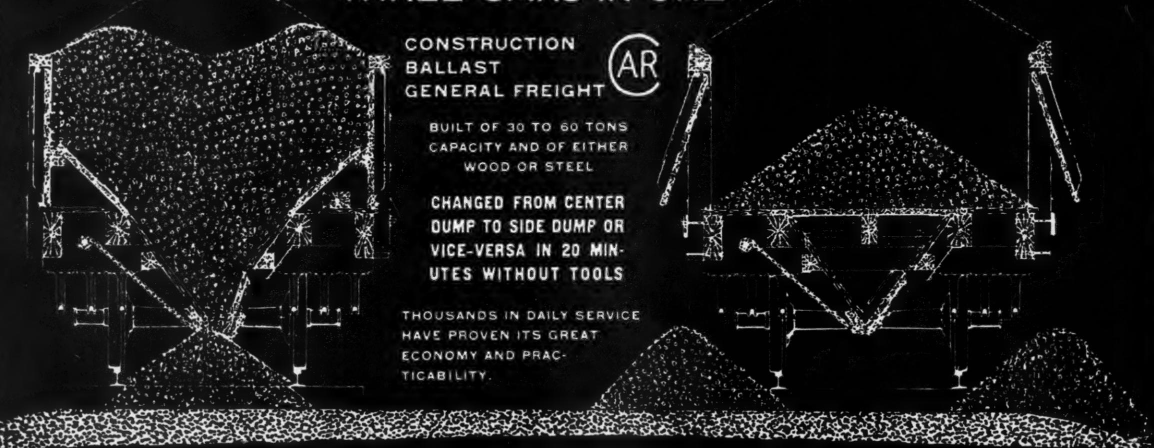

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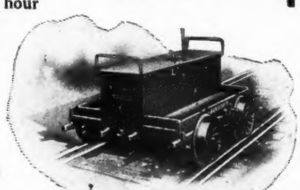

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Vol. 5 No. 10 BRIDGES-BUILDINGS-CONTRACTING-SIGNALING-TRACK October, 1909

Contents

Devices for Spring Rail Frogs

Of the many devices used with spring rail frogs a few are illustrated herewith. Opinions as to the value of the devices designed for the same purposes are, of course, at variance. They should be simple above all things, durable and absolutely sure in action.

The design of spring which is used most extensively consists of two boxed coils, one on each side of frog, with a bolt rod passing through frog and springs. This spring is located either

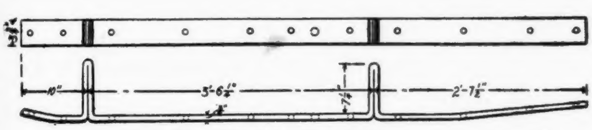


Figure 1—Reinforcing Bar.

ahead of or back of the point. When ahead of the point, it should be placed in the throat of the frog where the wing rails are parallel to each other; when back of the point it is from 12 ins. to 20 ins. from the point. This style of spring is the best practice and is much better located in the throat of the frog. In the case of a very long wing rail its action is supplemented by an auxiliary box spring on the outside of movable rail near the heel in combination with a hold-down device. Another design consists of a spring on the side opposite the spring rail and connected to it by a rod, passing under the rails and fastened

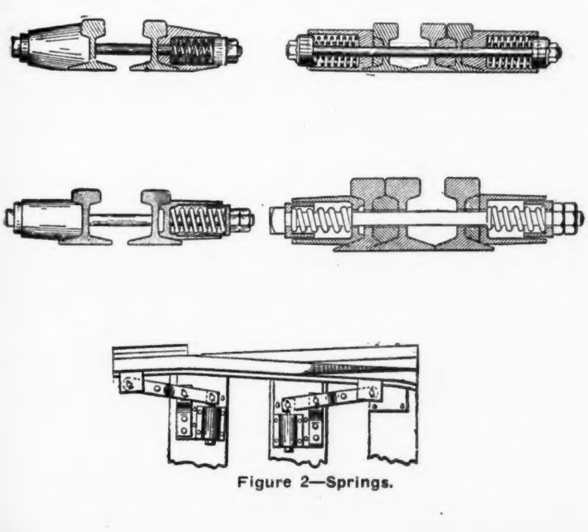


Figure 2—Springs.

to the reinforcing plate of the spring rail. A third design consists of two boxed springs located at side of spring rail which is operated by means of hinged arms. These last two designs, however, are rapidly becoming obsolete.

The anti-creeper prevents movements of spring rail with relation to fixed rails of the frog, and thereby keeps the spring from binding and checking the movement of the spring rail. One of the devices used for this purpose is a toe block, Fig. 7. A second device consists of a strap bolted to the spring and turn-out rails at the mouth of the frog, Fig. 4. A third device (Fig. 3) consists of a pivoted arm in the mouth of the frog, the arm being attached to the fixed wing rail and the spring with rail by clamps and bolts. Fig. 6 shows a fourth method

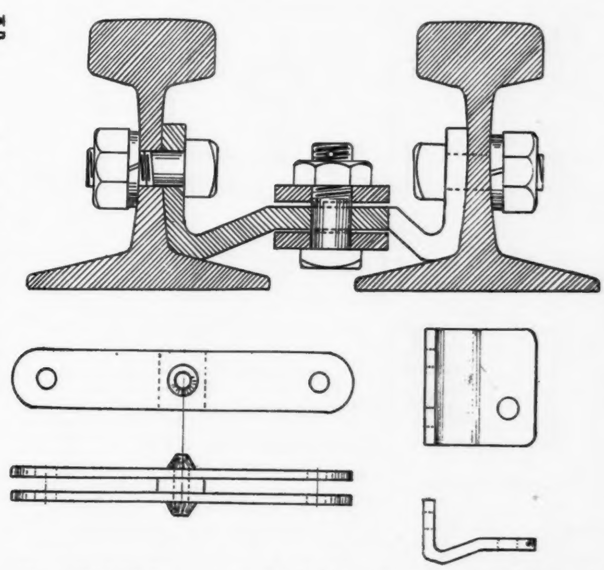


Figure 3—Anti-Creeper with Detail Views Drawn on One-Half Scale.

of preventing creeping by means of a hinge rail attached to the main rail by a bolt hinge and to movable part of spring rail by bolts. Other devices consist of one or two hinged links on spring rail side and are in combination with spring or hold-down devices. Fig. 5 shows a combination anti-creeper, hold-down and stop, used largely on a form of yard frog, having two movable wing rails with no springs which gives solid crossing for the wheels on either track.

The hold-down devices for the spring rail usually act as stops. A common hold-down device consists of a guide box

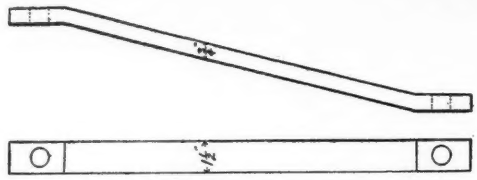


Figure 4—Anti-Creeper, Plain Strap.

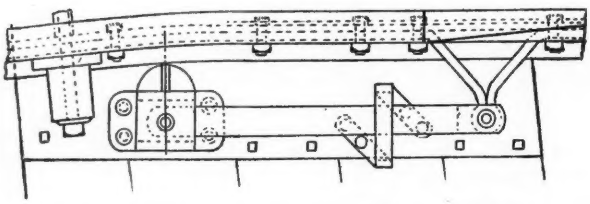


Figure 5—Combination Anti-Creeper, Hold-Down and Stop.

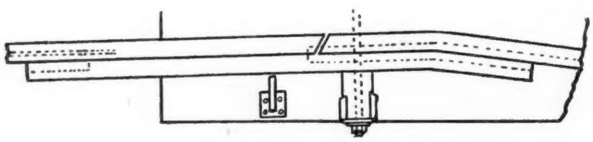


Figure 6—Anti-Creeper, Hinge Rail.

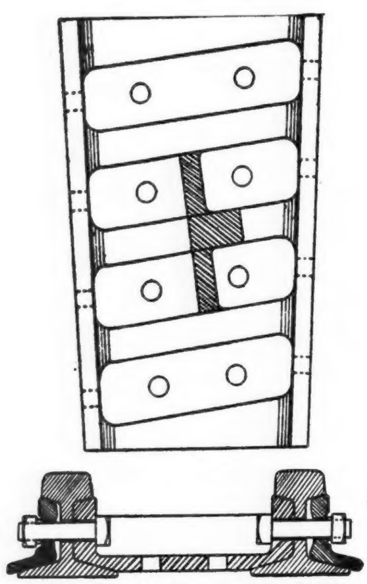


Figure 7—Anti-Creeper, Toe Block.

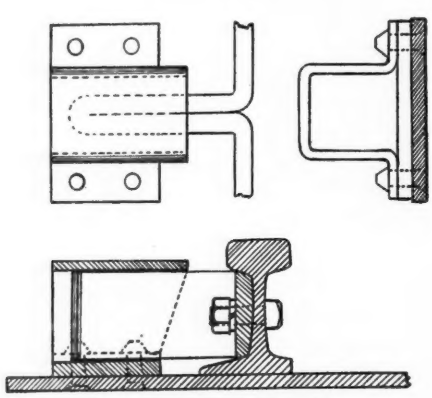


Figure 8—Hold-Down Device.

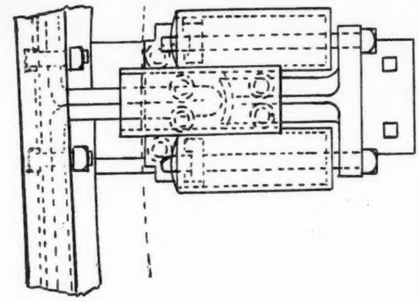


Figure 9—Combination Hold-Down and Spring.

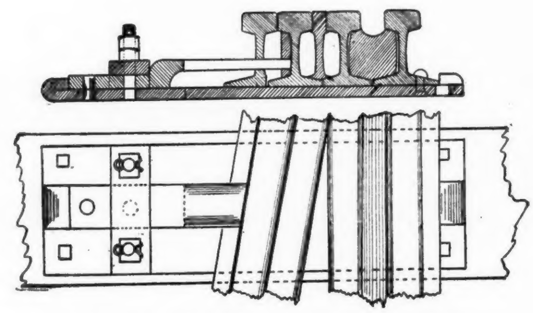


Figure 10—Hold-Down, Used at Heel End.

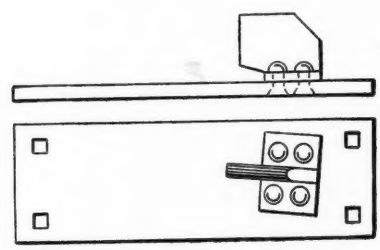


Figure 11—Stop, Riveted to Tie Plate.

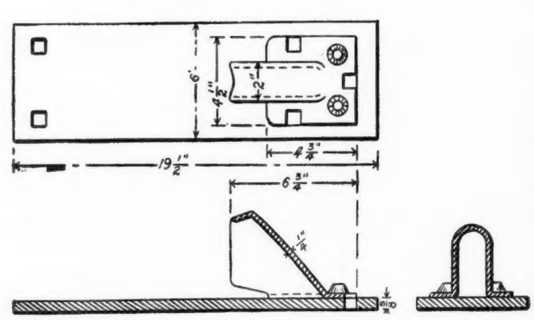


Figure 12—Stop, Riveted to Tie Plate.

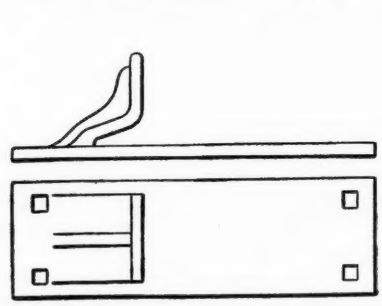


Figure 13—Stop, Rail Brace.

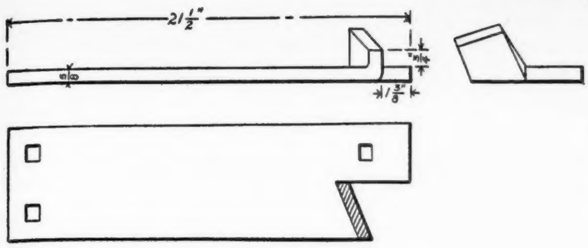


Figure 14—Stop, Tie Plate with End Turned Up.

and a bar or lug projecting from the spring rail. Instead of the separate bar a better way is to bend the reinforcing strap out to form projections, as in Fig. 1, which slide in the guide boxes. In most cases two of these devices are employed, one near the outer end of the movable rail and one near the point. In combination with two of the devices described above, a plate and rod are sometimes used at the outer end, the rod passing through the spring rail and riveted or bolted to the point rails. Another method of holding down the rail is to rivet the spring rail to a plate at the outer end. Another device consists of a hinged arm combination anti-creeper and hold-down.

Besides the hold-down devices there are from one to five other stops used for the spring rail. Various designs of rail braces are used, the braces being cast with the tie plate, or riveted or bolted to it. Tie plates are also bent up at the ends to form stops for the base of the spring rail.

A spring rail frog for the best standard practice should preferably have a reinforcing bar and hold down as shown in Figs. 1 and 8, stops like that in Fig. 11, pivoted arm anti-creeper as in Fig. 3. The springs should be at the throat, of the form shown in Fig. 2, backed up, in the case of a very long spring rail, by an auxiliary box spring near the outer end. The fixed rails should be riveted to a long single plate and there should be cast or rolled steel fillers with bolts between the fixed wing and point rails and a hard steel heel block between the point rails. No frog of greater number than a No. 12 should be made with movable spring rail.

The Maintenance of Way Department

Track Drainage

Editor, Railway Engineering:

Drainage is a very important matter in the maintenance of track, and I am going into it quite extensively on my division on account of a great many wet cuts.

I find the best time to ditch cuts is during the dry part of the summer, as material can be handled much cheaper when it is dry.

In making open ditches in cuts, I make the bottom of ditch about 4 to 6 inches below the bottom of ballast under track to insure the proper drainage of ballast; also slope the ditch with a nice easy slope from ballast line (which is 5½ ft. from rail) back to back side of ditch which is usually 9 to 11 ft. from rail. I have abandoned the idea of making deep ditches in cuts for this reason—that a year or two after new cuts are made they become sodded over and deep ditching usually undermines the face of cuts and is apt to make them slide.

In putting in drain tile, I never use anything less than a 6-in. clay drain tile, and a larger one if conditions require it. The best method I have found for laying drain tile is to have experienced men to dig the ditches three feet below the surface of the open ditches I have described. If material in bottom of ditch is hard clay or black soil, we lay them on the soil after bottom of ditch is properly leveled and graded. If sand bottom or any other soft material, we use a 2x6-in. timber to lay tile on in order to maintain a perfect grade for tile. I have ditches filled with either fire box or head end cinders account of being the most porous material we can get which allows water to get to tile quickly.

After tile has been laid I have all the dirt taken out of cuts that has accumulated from the rigging of tile ditches and cover the bottom surface of open ditch with two or three inches cinders which I find makes them much easier to keep clean.

Yours truly,

Iowa Roadmaster.

Drainage of Track

Editor, Railway Engineering:

Relative to the different items connected with the drainage of track, I will say that I consider this one of the prime features in railway construction, and am strictly in favor of the mistake of too much drain opening in first construction, rather than risking too little; as a mistake on the side of the latter can always be remedied in after years without incident washouts attended by consequent expense caused by the former.

Ditching and changing of creek channels is sometimes desirable, but in the change of channels where two streams are thrown into one, caution should be exercised in the width of opening, always to be reckoned from the additional area of water shed thrown to one common point of opening. I always avoid as much as possible the concentration of water along the ditches in cuts, and seek to divert such in a different direction if possible. My specifications call for ditches in cuts to begin at a given point from the center of the road bed, and to have a slope downwards towards the outerside of the cut, the ditch next to the bank to have the same slope as the bank itself.

Tiling being used by this company is cast iron, three and five-foot lengths, made by the American Casting Co., of Birmingham, Ala. This pipe has four spiral projections on the inside of the bell, and corresponding projections on the spigot end, those of the spigot fitting in between those of the bell, and by slightly turning the pipe after penetration the joints are forced to lock, thus making a very taut and rigid joint. They can be placed by two or three men very easily. Clay pipe and corrugated iron I do not like, though they are used extensively in this part of the country.

The width of berms according to my specifications are governed by the height of the banks, and range from six to ten feet, ten feet in my estimation being sufficient for any height.

Yours truly,

Chief Engineer.

Cattle Guards, Frogs, Switches and Tie Plates

Editor, Railway Engineering:

Relative to cattle guards, we use a surface guard which consists of small triangular pieces made in sections of about eight feet in length, the entire guard being composed of three sections; one for the center of the track inside of the rails and the other two pieces for outside of each rail. This guard is in no way effective, about as much so as any other surface guard that I have had any experience with. The fact is that I have never seen a positive guard except the old pit guard and know of some lines that are going back to them especially where cattle are not as domestic as in this country. I have in mind Texas.

Concerning spring rail frogs and split switches, spring rail frogs are in general use on the main lines of this system ex-

cept in the yards and in our ore traffic territory where a large number of manganese frogs are being used, the latter having been found more economical on account of longer life. Besides it has ben found not to be good practice to use spring rai lfrogs in yards or cross-overs for the very good reason that one track is used as much as another, there being no advantage in the use of the spring rail frog except as heretofore stated, for main line use.

This company has adopted 1-11 angle frogs as a standard for turn-outs and cross-overs, but we have lesser angle frogs for special purposes, such as guantlets where we are using single track over bridges, tunnels, etc. We have some that are termed Economy Switch Points consisting of hardened metal from the point for a distance of two feet. We also have some Wharton Switch Points that are twenty feet in length, composed of hardened metal from the point for a distance of 6 feet. These latter points are giving excellent service, having been in service for the past two years and showing little or no wear notwithstanding that nearly ten million tons of ore passed over them in 1907, three million in 1908 and seven million tons will have passed over them at the close of this season, besides a very heavy movement of grain during season in addition to the regular business which consists of several passenger trains in each direction and regular schedule freight trains.

I can not think of any thing further to say that will be of any value and as above stated, it may be that you will not consider what I have said fit for publication.

I regret to state that I have been out on the line so much this season that I have not been able to follow the valuable discussions that have taken place in your valuable paper, but would like to see the matter of placing tie plates threshed out, on account of their being such a large number of different kinds of methods employed in the placing of them. Presume that the kind of plates would have considerable to do with how they are placed. We have had plates without any corks or grooves, they being merely flat bottom. In such cases they can be applied at the time rail is being laid without any difficulty. We are now using a plate similar to the "Goldie."

I understand that the C., M. & St. P., besides other lines, are placing tie plates in position in the ties before they are laid, with some kind of an air apparatus and with great success. We have a tie plate gauge that is in use on this line but can only be used for relaying, it being necessary to place one end against the rail. We depend largely on the placing of tie plates with the traffic but it has been found not good practice account more or less variation of gauge and shoulders failing to fit properly against the outer edge of base of rail.

I wish that you could, if you care to do so, prevail upon the many subscribers and men who have an opportunity of trying out the different and various methods, to give us the benefit of their experience on this subject as it is such details of work that is usually of the most importance.

Yours respectfully,

WISCONSIN ROADMASTER.

Cattle Guards

Editor, RAILWAY ENGINEERING:

In regard to cattle guards, we are using two types of cattle guard—one is the ordinary triangular strips nailed to the tie with wings at the sides of the track, and other type is one that we have been required by law to put in in Arkansas, this being a pile bridge with the ties beveled on top.

Yours truly,

ILLINOIS ENGINEER.

Cattle Guards

Editor, RAILWAY ENGINEERING:

In reference to cattle guards, we have several different styles of surface guards, but cannot say that they are very much of a success, as the cattle in front of a train are liable to run over the guard. In fact, no cattle guards that I am aware of give as good satisfaction as the old pit guards, which of course are dangerous to trainmen.

Yours truly,

ASST. CHIEF ENGINEER.

Frogs and Cattle Guards

Editor, RAILWAY ENGINEERING:

We are useing the Eureka No. 9 spring frog made by the Elliot Frog & Switch Co., in our main line with 74-foot lead, using 15-foot switch point. In regard to cattle guards, we are using the Sheffield surface guards through states where they have stock law. Through other states where stock runs at large we use the pit guard, driven six piles to the guard with 12x14x9-foot stringers and 7x8-in. ties set up diamond fashion.

Yours truly,

ILLINOIS ROADMASTER.

Tie Plates

Editor, RAILWAY ENGINEERING:

Your letter received some time ago but have been so busy. I enjoy reading the Maintenance of Way Department in Railway Engineering.

In reference to tie plates, I have had about twenty-five years' experience in the use of tie plates—three different kinds, the Servis, Glendon and the Goldie Claw. I also have watched with interest different kinds of plates, that is the way they are wearing, and I find that the Goldie Claw tie plate is supreme. It is far ahead of all other plates made as it gives the best satisfactory results both in lasting quality and keeps rails in proper place under all conditions, also is excellent in holding rail from creeping.

Yours truly,

PENNSYLVANIA ROADMASTER.

Rigid and Spring Rail Frogs

Editor, Railway Engineering:

We beg to advise that the following list will indicate the principal dimensions of the frogs we are using:

No.	Theoretical Point to heel	Theoretical Point to toe.	Length Over all.
4	4-ft. 4-ins.	2-ft. 8-ins.	7-ft. 0-ins.
5	5-ft. 0-ins.	2-ft. 6-ins.	7-ft. 6-ins.
6	6-ft. 0-ins.	3-ft. 6-ins.	9-ft. 6-ins.
7	7-ft. 6-ins.	4-ft. 6-ins.	12-ft. 0-ins.
8	7-ft. 6-ins.	4-ft. 6-ins.	12-ft. 0-ins.
9	9-ft. 0-ins.	6-ft. 0-ins.	15-ft. 0-ins.
10	9-ft. 0-ins.	6-ft. 0-ins.	15-ft. 0-ins.
12	10-ft. 9-ins.	5-ft. 9-ins.	16-ft. 6-ins.
15	12-ft. 0-ins.	8-ft. 0-ins.	20-ft. 0-ins.

The above applies to both rigid and spring rail frogs. All of our frogs are combination bolted and riveted. Bolts pass through wing rail and frog point at intervals, with filler blocks between to stiffen the rails and the entire frog is then riveted to a ¾-in. base plate, varying in length for the various angles of frogs as follows:

No.	Rigid Frogs.	Spring Rail Frogs.
4	4-ft 0-ins.	5-ft. 5-ins.
5	4-ft. 0-ins.	5-ft. 6-ins.
6	4-ft. 10-ins.	6-ft. 6-ins.
7	7-ft. 0-ins.	7-ft. 0-ins.
8	7-ft. 0-ins.	7-ft. 6-ins.
9	8-ft. 0-ins.	8-ft. 0-ins.
10	8-ft. 0-ins.	8-ft. 4-ins.
12	8-ft. 6-ins.	8-ft. 4-ins.
15	8-ft. 6-ins.	8-ft. 6-ins.

The difference in length is merely to suit some detail of mechanical construction. We use rigid frogs in all of our yards, and rarely put in anything above a No. 8, preferring that angle

as a general proposition. We have quite a number of No. 7's and a few No. 5's and 6's to suit certain conditions. With present heavy drill engines nothing below a No. 8 is advisable. Lesser number of frogs with sharper curvature are hard to maintain and invite derailments.

On our main tracks at outlying switches we use No. 10 spring rail frogs. At all interlocking plants we use No. 10 and 15 rigid manganese frogs, the No. 15's for reasonably high speed movements and the No. 10's for slower movements.

We feel that at interlocking plants and in hard service yard tracks manganese frogs are decidedly economical, giving us from ten to fifteen times the life service of an ordinary Bessemer or Open Hearth frog.

I am not prepared to say that our design of frog is superior to many other patterns that have come under my notice. I believe, however, that our rigid frogs give as good service as any other special or manufacturer's design.

You will note the great variation in the lengths of our frogs. I am of the opinion that all railroads are gravitating toward the point where the length will become more uniform. I see no reason why all angles between No. 4 and 10 inclusive should not be 15 feet long and from No. 10 to 15, twenty (20) feet long; from No. 15 upward to No. 24 another uniform length. I have used such frogs and think I secured a more rigid piece of work and was able to maintain alignment better than with the shorter frogs. The same idea applies to switch points.

I believe every condition could be met with switches 10, 15, 20, and 30 feet in length with an occasional exception where the work was special or the frog used below a number 4.

Yours truly,

ENGINEER, M. OF W.

Cattle Guards

Editor, RAILWAY ENGINEERING:

With reference to cattle guards, I use the combined culvert and cattle guard; that is to say, we put in two wall plates on mud sills across the roadbed with a depressed 6-foot opening, with a 12x14 stringer 8 feet long, with 4 ties 7x8-in.x14-ft., spaced 2-ft. 8-in., center to center. In nearly all cases our guards answer for culverts.

I have tried the V-Slat guard. It will generally stop sheep, but horses and cattle when cornered by moving trains will attempt to go over it. We are in this country making a strong effort to get the municipalities to adopt and enforce the Domestic Animals Act, so that no animals will be allowed at large without some person being in charge, which would obviate the necessity for cattle guards.

Yours truly,

CANADA ROADMASTER.

Cattle Guards, Frogs and Switches

Editor, RAILWAY ENGINEERING:

Just at present I am extremely busy and don't feel as though I have the time to go into the matter as thoroughly as I should in order to send you a paper that would be printable in your magazine. I will say, however, with regard to cattle guards that I have yet to find a cattle guard that is absolutely cattle proof. I understand that guards are made which will positively prevent stock from getting on to the right-of-way, but that they are either too expensive to be put into general use or else are built in such a manner that they will not work under all conditions.

In the latter case I have in mind a cattle guard that was used on a railroad here in the west. It was made from an iron man and worked automatically. When the train got within a certain distance of the crossing it would release a spring and the man who stood in front of the crossing with his arms extended would collapse and drop down into the track. This style of cattle guard was very effective, but in winter when there was snow and ice it failed to work.

With regard to placing switches and frogs, in laying a turnout of any kind we first install our head block and switch ties, then place our frog and throw out the rails that formerly connected with the main line where the frog goes as the outside rail of the lead to the side track and out of new rails lay our main line lead and the opposite side of the lead that was just thrown out. Of course our distances between head block and point of frog depends entirely upon angle of frog used. Out here our standard turn out is No. 11, but in some cases we use a No. 15 and at all times use a spring frog. We use a fifteen foot switch point with two tie rods. The one nearest to the head block is also used as a head rod onto which the connecting rod fastens. Our frogs are single guarded and are used in connection with a fourteen foot guard rail without clamps or bolted fillies.

I have often thought that you could create a very interesting discussion on how steel should be laid with respect to broken or even joints, which was the best and for what reason.

Yours truly,

MONTANA ROADMASTER.

Maintaining Track

Editor, RAILWAY ENGINEERING:

The following is my method of handling ordinary track repairs. Beginning in the early spring, assuming that track has been maintained in ordinary riding condition through the winter by use of shims or other practical means. As soon as the frost is out of the ground or the wet season done I start by distributing 300 or 400 ties over an entire section as the train moves along. These ties are to replace the broken or extra bad ties. Our foremen are then instructed to start on the worst places first, raise the worst spots, line kinks and put in ties. In the course of a couple of weeks the gang has passed over tthe section with these light repairs, then turning back on the worst track they make permanent repairs, putting in what ties are needed, and stopping from time to time to repair rough spots needing immediate attention.

This process is continued through the year in rock ballasted track until track is frozen down hard and fast. Every spare minute or every minute that can be had is spent in this kind of work. Dirt track, in wet season in the south west, should not be disturbed more than can be helped and when necessary to shim, shim from bottom of tie. When working through cuts I endeavor to have them ditched while the gang is near, saving a second trip or possible chance of not getting back, always keeping in mind drainage at any and all times of the year. Like surfacing, it is a good class of work to do any time it can be done, and money so invested pays a good interest in return.

These notes are written hoping they may prove of some value to some young roadmaster or track foreman. I do not wish to set myself up as an authority among neighboring roadmasters, but this method is good even for old timers to follow.

Yours truly,

A CALIFORNIA ROADMASTER.

Varieties of Tie Plates*

In nearly every case the early tie plates were too thin, and it was found that, while they had a tendency to offer lateral resistance to the rail, they quickly cupped under heavy traffic and either rusted or wore out. The next step was to increase the weight of the plate, but a new difficulty was met when the thickness of the plate became proportionate to the size of the spike, in that it made a cutting surface on both sides of the outside spike. It was then necessary to have some protection for the side of the spike next to the rail and a shoulder plate was designed. This practically did away with all the difficulties of preserving good alignment and preventing abrasion of the ties, but it was found that the tie plate was apt to become

*From a committee report to the Roadmasters' and Maintenance of Way Association.

loose under the jar of the wheels and rattle with the passing of every train. In attempting to avoid this feature a plate was made with flanges underneath to sink into the tie. In adopting this feature it was also the intention to so design the plate that it would offer additional lateral resistance to the rail. In the class of plates intended to attach themselves to the tie we have the flange plate already mentioned and a plate with short spikes or a claw device that are the most generally used.

FLAT-BOTTOM PLATES.

We may say that the flat-bottom tie plate has for one of its recommendations its greatest fault, that of rattling when the spikes are loose. We all know that we are prone to neglect the tightening of spikes when other work is crowding us and if we have tie plates that attach themselves to the tie or no tie plates at all the loose spikes are not nearly so noticeable as when flat plates are used. These plates have been used where the spikes were all tightened each season or every three months, and there was very little rattling. Unless we are prepared to set a time to tighten all spikes, and then see that they are tightened we cannot consider the use of the flat-bottom plate on any up-to-date road. We all know the annoyance loose bolts in switches will cause, but consider the condition of a road if every tie was provided with two loose tie plates. When good ties are used and the renewals are not stinted there is no question but that the flat-bottom plate will meet all requirements that we now demand of a tie plate. One of the committee has a district 150 miles long, of which 67 miles is a trunk line used by two of the largest roads in the Middle West. On this piece of track he has nothing but heavy tie plates of the flat-bottom type, with a shoulder, and there has not been a case of track spreading in the past eighteen months. Both before and after he had been assigned to this committee he has examined as many of the ties under these plates as possible and he has found but very few cases of decayed ties, and of these he was not of the opinion that the plate was in any way responsible for the rotting of the tie. It seems to us that if these plates are a success in this case they would answer the purpose on any road.

FLANGE PLATES.

The design of the flange tie plate, as it is being made for present use, aims for strength in every line. The flanges are rolled from the face of the plate and materially increase the rigidity of the plate. On soft wood ties there is no question but that the present heavy flange plate is the ideal pattern. In sinking the flanges of the plate into the soft wood the fibers are compressed, furnishing a harder surface than they would otherwise have, to receive the blows from the rail, and also having a tendency to prevent the spike from working up out of the tie.

It attaches itself to the tie and will not rattle under traffic. If properly applied, so that the flanges are buried in the wood until the bottom of the plate is flush with the top of the tie, it will offer all the lateral resistance that is ordinarily required of a tie plate and it will preserve the tie from wear and from decay following the broken fibers. This plate, when properly designed, will carry a greater load than any other plate now being made, for impartial laboratory tests have shown that after the flange plate is sunk to the surface of the tie it takes more weight to sink it into the wood than any other plate. This test was made between a flange plate and a flat-bottom plate, both plates having been made by the same company, the test being made for the company's own information.

CLAW-PATTERN PLATES.

The tie plate made with short spuds on the under surface offers greater lateral resistance than any other type we have seen. The spuds being short provide the maximum resistance since the pressure comes directly under the rail and no leverage is given. The spikes on the plate when driven into the wood press against the fibers of the tie, causing the resistance to increase as the plate is forced out of line.

This plate has been used by one member of the committee on an eastern road where the traffic is very heavy and the country rough and he has not had an accident in several years on account of spread track. If properly put on we believe this plate will give greater holding power than any other plate and it will not rattle under trains.

APPLYING TIE PLATES.

It may be a broad statement to make, but after carefully considering the matter, the committee believes that any tie plate now on the market that is at least ⅜-in. thick, if selected for the work it is expected to do, will give good service if properly applied and taken care of after it is put in the track. The manner of applying tie plates is one thing in track maintenance that rarely ever gets the attention that it should get, and if the tie plates fail to give the proper results we are too apt to lay the blame on the tie plates and not on the work of applying them. We cannot too thoroughly educate the trackmen in the matter of properly using the tie plates after they are furnished. Until very recently the makers of tie plates had kept this matter before all railroads, but with the general adoption of tie plates the sales were so great that the manufacturers could not keep up with their orders and this educational advertising was dropped to a certain extent. We notice that this has been taken up again and will probably result in fewer failures of tie plates.

We consider the proper method of applying the three styles of plates mentioned above to be as follows:

(1) Flat plates should be put on a perfectly smooth, level surface which will provide a solid foundation for the plate and save the plate as well as the tie and the rail.

(2) Flange plates should have a smooth, level surface prepared to receive the plate, this surface to extend four or five inches beyond each end of the plate. The plates should be placed so that the outside shoulder will fit up to the rail and the plate should be driven down until the flanges are forced well into the tie, leaving no air space between the tie and the plate. This should be done with a tool that straddles the rail and bears evenly on both ends of the plate. This can either be struck with a sledge or with an improvised trip hammer. This style of plate should never be driven by striking the plate directly with a spike maul, as it is impossible to sink the plate true in this manner, and the plate is also liable to be cracked or bent. Another method that should never under any condition be followed is to tap the plate into place with a spike maul and leave it for the first train to sink, tightening the spikes afterward. When this practice is followed dirt will get under the plate before it is sunk and the plate never does get fully imbedded. This manner of putting in tie plates is very common and more tie plate failures have resulted from this than from any one cause that has come to our notice. When the tie plate is not properly sunk in the tie water can get under the plate and the plate bends or cracks, causing the tie to decay around the spikes and flanges and offering no protection to the tie by the defective plate.

Where the plates are properly applied the ties are very rarely found to be decayed under the plate, there is no rattling under trains and there will be sufficient lateral resistance for any ordinary purpose.

(3) The claw-pattern plate, being simply a flat-bottom plate with claws on the under surface, should be applied to a surface prepared for a flat-bottom plate. It should be applied in the same manner in a way similar to that as a flange plate, using more care, if anything, to see that the plate is driven down evenly than the flange plate, on account of not having the long flanges underneath to add surface strength to the plate and resist bending when being driven.

In considering the use of both the flange plates and the claw-pattern plates we should regard them as improvements on the flat plate, and in getting the advantages that they offer we must pay the price in extra labor for application. When they were

designed it was taken for granted that they must be applied according to certain rules and there are no tie plate makers who expect them to give good service if they are not applied as intended.

For the benefit of all tie plates we would recommend:

(1) All tie plates should be laid on ties that are equally tamped and of an even height with reference to the rail.

(2) Before selecting tie plates for any track the engineers should consider the track, and the ties in the track, and select the tie plates for the track in question according to the merits of the different plates, and not attempt to make all plates on the road conform to a given standard regardless of the conditions.

(3) All tie plates should be applied as instructed by the designer unless some improvement can be made over any instructions we have, but we should never lower our standard.

(4) All tie plates should be provided with four holes, in order to avoid making pairs that are liable to be separated. The holes should be punched so that the spikes will press tight against the base of the rail, but not tight enough to cause the spike to enter the wood slanting.

(5) Tie plates should not be put on until the track is in perfect alignment.

(6) Screw spikes should be used with all tie plates.

Committee—J. Sweeney, A. P. Bradley, C. E. Boone, A. L. Kleine, M. Foley, J. D. Boland and Jos. E. Gaunt.

Changing Rails and Laying New Rails*

I submit the following report for the best method of changing rail, or laying a new rail on steam railways. I give you this information as I got it by actual experience, in taking up 80-lb. rail and laying 90-lb. rail.

First, was the unloading of the new rail and fastenings. To unload the new rail I used a rail unloader, which was worked by air, furnished by the work engine, the operation of which took a foreman and five men besides the train crew. Any good handy man could run the loader. I made comparison with loading and unloading rail, and found that we could handle the rail considerably cheaper with the machine. It cost to unload the new rail and fastenings, per mile:

Labor	$ 9.75
Work train service	9.58
Fuel, oil and waste	7.58
Making, per mile for unloading, a total of	$26.91

This was on single track where we had an average of seventeen trains during the ten working hours. To get estimate of cost of unloading, took total cost of unloading sixty-five miles of rail, and divided by sixty-five, which gives the cost per mile, as some days we were hung up on account of trains and did very little work, and other days we could do more.

We loaded the old rail with the rail loader, and it cost practically the same to load it as it did to unload the new rail.

In laying this rail I used gangs of one foreman, assistant foreman, time keeper, two flagmen and forty-four men. Had my gangs organized as follows:

Six men with claw bars pulling spikes.

Three men with spike mauls to loosen up spikes that were stuck and to knock down stubbs.

Four men throwing out the old rail.

One man with nipping bar to cant the rails up out of the old bed, and three men to shove them out.

Three men driving plugs in the old holes, which should be distributed ahead of the work.

*Paper read before the annual convention of the Roadmasters' and Maintenance of Way Association, by John Barth, Supervisor, C. C. C. & St. L. Ry.

Twelve men with tongs to set in the new rail, which should be set in one rail at a time.

One good hustling fellow to put in the expansion shims and keep the rail gang moving, using steel cut nails for shims, making the expansion according to what the thermometer shows it should, by using different sizes of nails, putting the nail in crossways against the ball, so that it will be out of the way in putting on the angle bars. The first few trains over this nail will slip out.

Two men with bars with claws on one end and pointed on the other to shove the rail into the spikes at center and quarters.

Four men with spike mauls, these men to start off leaving eight ties unspiked between each man, and then continue going, each man spiking every eighth tie from the last one that he spiked, which would spike every other tie, and would prevent the men running around each other.

One man with a claw bar and adze to pull out the spikes that come in the way of the angle bars at the new joint, and to adze down the high ties at the new joint.

Five men putting on angle bars, and bolting up, putting two bolts at each joint, all bolts and angle bars to be distributed ahead of the rail laying, each day's work only.

Have plenty of wrenches and spike mauls, and when connection is being made, or waiting for trains, turn the men that are working in the tong gang and those throwing out rail, back full bolting and full spiking.

Two men with a push car, to keep the connection rails, off-set splices and everything needed in making a connection, and extra tools, right with the rail laying, so that when connection is to be made they will be on the ground. Have the spikers and bolters in starting out assist these two men in loading the connection rails. Always move the last new rail ahead and use it as a connection rail all the way through. This will always give you a good joint.

The foreman should watch the time of the regular trains, and go ahead of the spike pullers, and pick out his place for making a connection, and have four picked men out of the gang that set in the rail to make the connection, using short pieces of rail. I used pieces up to 4 ft. long. Used off-set bars from 90 lbs. to 80 lbs. I always found that my new rail fell short. I was putting down 33-ft. rail and taking up 30-ft. rail, and every ten rail lengths we could make a good connection by pulling the 80-lb. rail against the 90-lb. and using short pieces of 80-lb. rail to fill in the gap. In closing up at night if I thought it necessary I would cut in a long piece of rail.

The two men handling the push car and keeping the tools and connections up with the rail laying also maintain the tools in good repair, such as keeping handles in the mauls, and have a general supervision of the tools.

The assistant foreman to be back among the work, and see that the track is kept safe spiked and bolted, and ready for trains by the time a connection is made.

Section men to follow up and tamp any ties that may be hanging or shim them up as the season of the year may require.

Gage the track when you space the ties, as you will have to do it at that time anyway, and it avoids cutting up the ties with spikes. In taking up 80-lb. rail and putting down 90-lb. rail, pull the outside spikes of both rails, as in doing this you avoid adzing, as the new rail will set up on the shoulder of the tie on the outside and give the wheels a full bearing on the ball of the rail.

In taking up and laying rail of the same size, pull the inside spikes on both rails, and adze the ties down so as to give the wheel a perfect bearing on the ball of the rail. To do this it would take five extra men above the forty-four to do the adzing.

Full bolt and spike the new rail and uncouple the old rail as

far as you go each day. This usually can be done while waiting on trains. If not, take the time to do it. This is the reason I did not work larger gangs of men, as forty-four or forty-six men just about cleaned up each day's work even.

This rail laying was done on single track where we had an average of 17 trains in our 10 working hours, and was laid at a cost of $134.24 per mile. We laid an average of 3500 ft. of rail per day.

Joint Splices*

The first angle bars used, of which we have any record, were in the year 1868. These were similar in form to those in use on many of our railways at present, with the single exception that the inside of the bars that fit against web of rail were made perfectly flat. In 1870, both the fish plate and angle bar were improved by making the inside of bar concave, so that only the top and bottom of the bar came in contact with the rail. This change not only made a stronger bar, but reduced the work of tightening bolts.

In 1875 the Pennsylvania R. R. adopted what was known as the "re-enforced angle-splice bar," being similar to the ordinary angle bar with the exception that for a distance of three inches each way from the center of the bar, it was made from a fourth to a half inch thicker than the remainder of the splice, as experience had shown that 90 per cent of the breakage of fish plates and angle bars occurred directly opposite the rail ends, which clearly demonstrated that this particular part of the bar was subjected to the severest strain, hence the reason for re-enforcing it at that point. The C., B. & Q. R. R. adopted this form as standard on their lines in 1879. In 1880 the Pennsylvania R. R. people further improved this type of angle bar by making it some two inches wider than the base of the rail and turning the part that projected beyond the base of the rail downward, so that it rested flat on the tie. This not only added to the strength of the bar, but served as a bed plate as well, preventing the destruction of the joint ties for the reason that the blow at joint was distributed over a wider surface.

This form of joint was generally used as standard by most of the prominent railways until the year 1888, when the crying need for a better rail joint to support the ever-increasing traffic and weight of equipment woke up a whole army of inventors, the efforts of all being concentrated on one subject, viz.: to adequately support the rail from beneath, to the end that it might withstand the terrific hammering from above. Among the first joints of this type was the "Fisher," designed by Clark Fisher, C. E., and used in considerable numbers by the Boston & Providence R. R. in 1888.

In 1894 the "Heath" joint, named for its inventor, came to the front and was sold in large quantities to many of the leading railways of the country. This joint was made in two parts, the inside a plain fish plate, and the outside a combined angle bar and bed plate, the latter having a depending truss in the center. This joint was guaranteed, before it was used to any extent, to hold up the rail ends under any and every condition, prevent "dubbing" or battering of rails, spreading gage, etc., etc. It was also a noiseless (?) joint. In brief, this joint was to overcome all the objections to, and weaknesses of, all former joints, but in two or three years those who had been loudest in its praise, were the most emphatic in its condemnation, and the "Heath" quickly found its way to the railroad potter's field, the scrap bin.

After this costly and disastrous experience most of the railroads settled down to the belief that there was nothing better in the way of a joint than the 24 and 36-in. re-enforced angle bar previously mentioned, and for several years very little progress was made by the different inventors in having their many devices even tried by the leading railroads of the country, and they were put off with the assurance, "We have a perfectly satisfactory joint; why should we change our standards and spend a whole lot of money for a device that may prove to be not so good, or infinitely worse than our present joint?" But companies with large capital back of them put the shrewdest—I was about to say "salesmen," but will use the word "diplomat" instead—in the field and these men, like "Banquo's ghost," would not down, and when they came in contact with a manager who refused to listen to them on the ground that his company was too poor to do any experimenting they would cheerfully offer to place a mile of their joints free of cost on his line in order that they might be given a practical test.

It had been slowly dawning on all concerned in maintenance-of-way matters, that the ordinary angle bar was a back number under engines of the decapoed type, and something had to be done. As usual, the roadmaster, who has been justly termed the "watchdog of the track department," was the first to discover this weakness and call the attention of his superior officer to it.

Among the prominent joints of the sub-supporting type struggling for recognition at that time we find the American, Continuous, Weber, Atlas, Bonzano, Thompson, Girder, Wolhaupter and many others making similar claims for superiority over the fish plate and angle bar, all of which possessed more or less real merit but did not reach the requirements of a perfect joint fastening.

What, we ask, constitutes a perfect rail joint? Quoting from no less an authority than the Engineers' Maintenance of Way Association in convention at Chicago, March 21, 1905, we find the consensus of opinion of that very able and conservative organization embodied in the following set of resolutions covering requirements for standard rail joints and which were unanimously adopted at that meeting as follows:

First—"It must connect the rails into a uniform and continuous girder."

Second—"It must be strong enough to resist deformation or taking permanent set."

Third—"It must prevent deflection or vertical movement of the ends of the rails and permit movement of the rails lengthwise for expansion."

Fourth—"It should be simple and of as few parts as possible and be effective."

Fifth—"Finally, its cost must not be prohibitive."

Taking up these resolutions in consecutive order:

First—Have we a rail joint on the market today that really connects the rail ends into a uniform and continuous girder? Before we can justly make such a claim we must elimiate the wheel blow at the joint and its resultant noise; we must, in fact, make the joint as noiseless and as easy to maintain in line, gage and surface as any other part of the rail; and we state that this has not been fully attained by the best joints on the market.

Second—We know of no joints now in use that successfully resist deformation or permanent set, either of the rail ends or the joint itself.

Third—If we had a joint that really prevented deflection of the rail ends or vertical movement the joint would at once become as easy to maintain in surface as any other part of the rail. It would do away with battered rail ends and wear on the joint itself under the head of the rail and reduce the cost of maintenance, to say nothing of prolonging the life and usefulness of both joint and rail.

Fourth—A joint to conform to this particular requirement should be simple, easily applied and consist of not more than two parts.

Fifth—In order to avoid prohibitive first cost it would be desirable to have the parts of a form to be made by rolling.

*From committee report to the Roadmasters' and Maintenance of Way Association, J. E. McNeil, chairman.

It is the opinion of the committee that the base-supported joint, while not perfect, is the best type now in use, for the reason that it does not depend so much on the bolts for its strength as does the joint without a base plate, and the load is carried from one rail to the other without so much vertical action between the rail ends, as is noticeable in joints without base plates.

In regard to the insulated joints: We believe many of our standard joints now in use may be insulated, but the base-supported type appears to be the most satisfactory. A chief signal engineer of a leading line writes us that he has been experimenting with all the insulated joints on the market for the last two years, but has not yet decided which he prefers, except that he favors a base-supported joint of some sort.

It is also the opinion of the committee that the acme of rail joint construction has not yet been attained and the field is still open for experiment. Some form of rail joint should be found which will prevent the wheel blow at the rail ends. This may be accomplished by using a splice bar of some sort to carry the wheels over the opening between the rail ends. Joints are now being tried in which the outside plate is brought up flush with the top of the rail so as to carry the wheels over the joint without battering the rail ends, instead of trying to produce a joint strong enough to withstand the blow. Maintenance of way men will, at first thought, object to this type of joint and claim that the worn flanges may strike the outside plate and cause rough track. This, at one time, was a more serious objection than it is since Master Car Builders' rules are being so rigidly enforced and spring rail frogs, split switches, riser rails, etc., have come into general use. We do not, at present, recommend this form of joint, but simply call attention to the experiment that is being made.

We are prone to discourage new devices in railroad construction and reach a swift conclusion that they are not practicable. Such conclusions are not always logical or safe to the men who are really seeking the truth. Let us not make the mistake of getting into ruts; the world is moving and we must move with it if we keep up with the profession. One thing is sure, if we get a better rail joint than we are now using some one must think about it. Invention requires thought, experiment and more or less money, and we are honestly asking each member of this association to study along the lines we have indicated, and not only this, but, if possible, persuade the management to make practical tests of your ideas.

We are under obligations to Mr. J. C. Rockhold, an old member of the association, but not a member of this committee, for valuable information on the subject.

The Signaling Department

Track Circuits and Insulated Joint

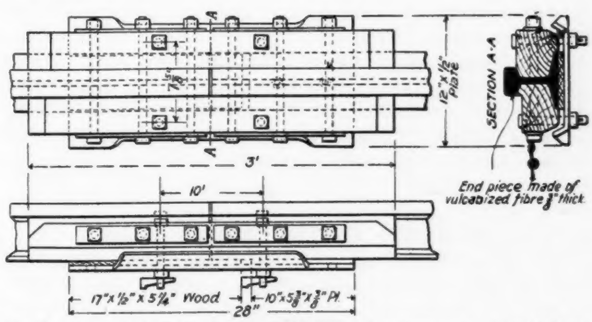
Editor, RAILWAY ENGINEERING:

I am sending you drawings "A" and "B" showing two schemes of track circuits; also print of drawing showing, in detail, our standard insulated joint.

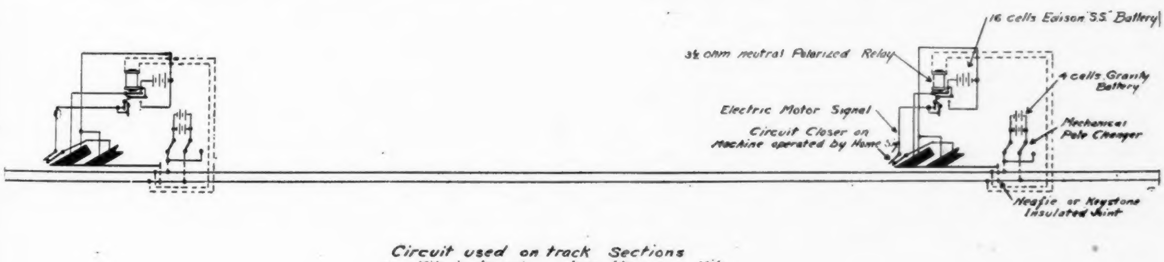
Drawing "A" shows scheme of track circuits which we use mostly and which is approximately 5,000 ft. We use four cells of bluestone battery, connected in multiple series and a 3½ ohm. neutral polar relay with 16 cells of Edison S. S. battery to operate our signal motor.

Drawing "B" shows track circuit exceeding one mile with a cut section between the signals. In this cut section we employ the usual 3½ ohm relay to change the polarity the same as sketch "A." We also use four cells of gravity battery connected in multiple series in all of our cut sections.

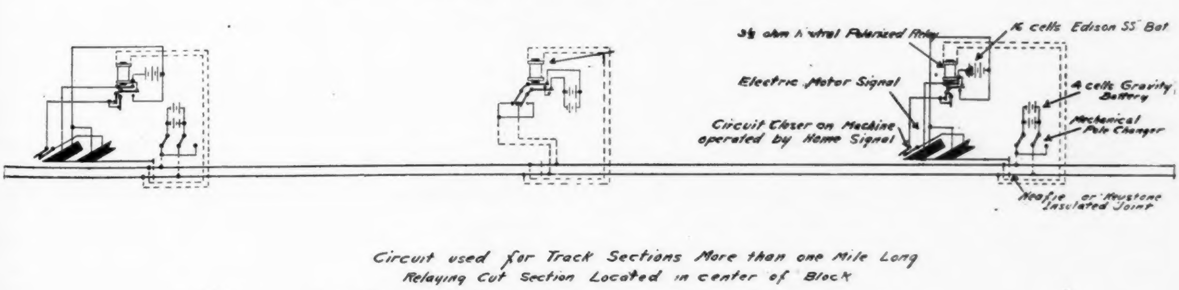
Print showing the Neafie joint, as I have said before, is standard on our road and as it is shown in detail, there is nothing that I can add.



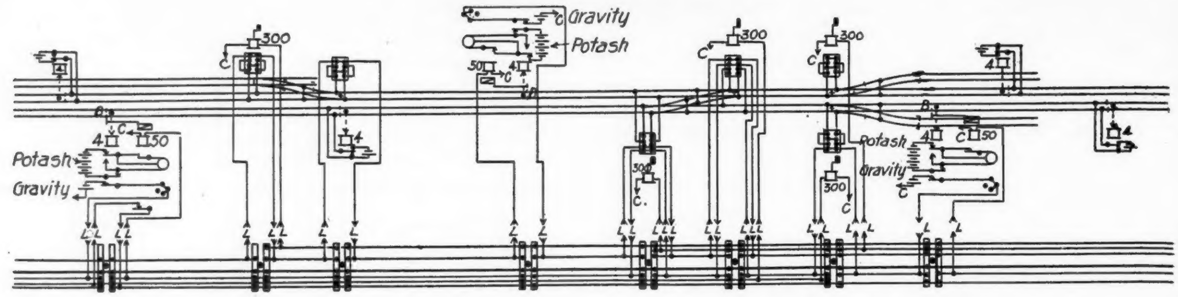
Neafie Insulated Rail Joint, Delaware, Lackawanna & Western Railroad.



Drawing A—Delaware, Lackawanna & Western Railroad.



Drawing B—Delaware, Lackawanna & Western Railroad.



Automatic Block Signals on Double Track, Polarized Line Circuits, C. R. I. & P. Ry.

Typical Circuit Plans

Editor, RAILWAY ENGINEERING:

I hand you herewith typical plans for automatic block signals on single and double track. I will say that, as the plans show, we use 4-ohm track relays and 50-ohm line relays. We use 2 cells of gravity battery for each track circuit, 6 cells of gravity battery for our line circuits and 16 cells of potash battery for operating circuits. The length of track circuits varies from 2,000 to 3,000 feet, according to local conditions.

Our signals all give three indications in the upper right-hand quadrant and at present are style "S" Union. The operating and line battery, also the track battery, where convenient, is placed in a concrete well adjacent to the signal. Other track batteries are housed in cast iron chutes.

Wires from pole line to apparatus are laid into a cable extending from the cross-arm to the cable post. We use as little underground work as possible.

At all switches on double track we have one switch indicator to announce the approach of trains. On single track where switches are remote from signals, we have in the majority of cases two indicators, one to announce westward and the other to announce eastward trains.

Canadian Pacific Signal Rules

The following rules are used on the Canadian Pacific railway by signalmen, enginemen and trainmen, and signal repairmen:

Signalmen.

1. The normal indication of home signals is Stop. (a) A back white light indicates that the clear signal is displayed. A back blue light on the home signal indicates that the stop signal, and on the distant signal that the caution signal is displayed.

2. Levers, or other operating appliances, must be used only by those charged with the duty and as directed by the rules.

3. Signal levers must be kept in the position giving the normal indication except when signals are to be cleared for an immediate train or engine movement.

4. When the route is clear, the signals must be cleared sufficiently in advance of approaching trains and engines to avoid delay.

5. Signals must be restored so as to give the normal indication as the train or engine for which they were cleared has passed them.

6. If necessary to change any route for which the signals have been cleared for an approaching train or engine, switches must not be changed or signals cleared for any conflicting route until the train or engine, for which the signals were first cleared, has stopped.

7. A switch or facing point lock must not be moved when any portion of a train or an engine is standing on, or closely approaching, the switch or detector bar.

8. Levers must be operated carefully and with a uniform movement. If any irregularity, indicating disarranged connections, is detected in their working, the signals must be restored so as to give the normal indications, and the connection be examined.

9. During cold weather, the levers must be moved as often as may be necessary to keep connections from freezing.

10. If a signal fails to work properly, its operation must be discontinued and the signal secured so as to give the normal indication until repaired.

11. Signalmen must observe, as far as practicable, whether the indication of the signals corresponds with the position of the levers.

12. Signalmen must not make or permit any unauthorized alterations or additions to the plant.

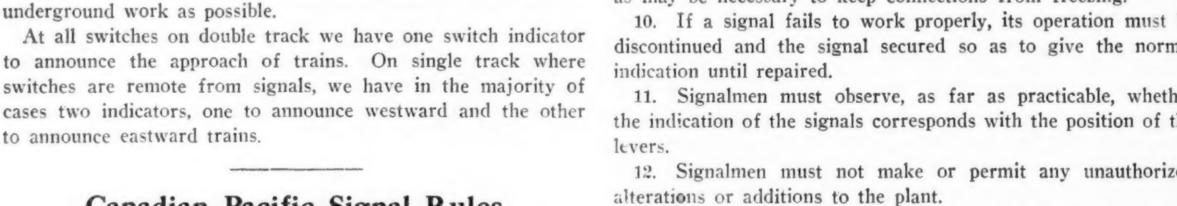
13. If there is a derailment or if a switch is run through, or if any damage occurs to the track or interlocking plant, the signals must be restored so as to give the normal indication, and no train or switching movement permitted until all parts of the interlocking plant and track liable to consequent injury have been examined and are known to be in a safe condition.

14. If necessary to disconnect a switch from the interlocking apparatus, the switch must be securely fastened.

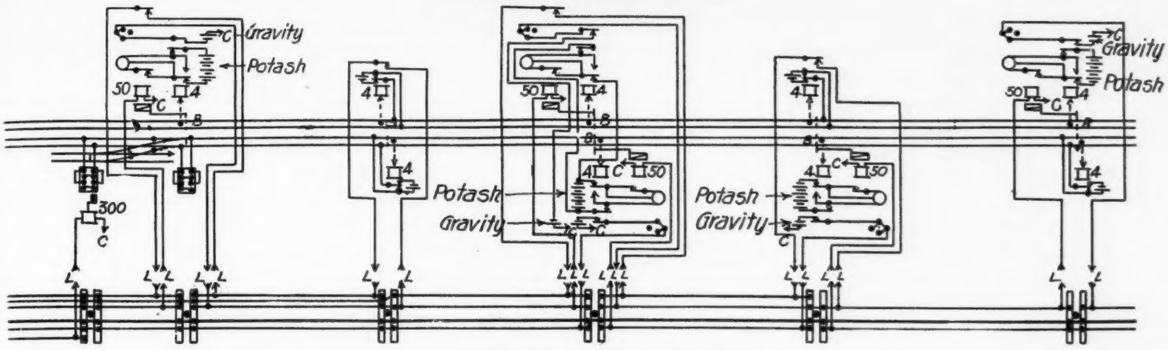
15. During storms or drifting snow, special care must be used in operating switches. If the force whose duty it is to keep the switches clear is not on hand promptly, when required, the fact must be reported to the superintendent.

16. If any electrical or mechanical appliance fails to work properly, the Superintendent must be notified and only duly authorized persons permitted to make repairs.

17. When switches or signals are undergoing repairs signals must not be given for any movements which may be effected by



Automatic Block Signals on Single Track, Polarized Line Circuits, C., R. I. & P. Ry.



Drawing Continued from Page 194 Opposite.

such repairs, until it has been ascertained from the repairmen that the switches are properly set for such movements.

18. Signalmen must observe all passing trains and note whether they are complete and in order; should there be any indication of conditions endangering the train, or any other train, the signalman must take such measures for the protection of trains as may be practicable.

19. If a signalman has information that an approaching train has parted, he must, if possible, stop trains or engines on conflicting routes, clear the route for the parted train, and give the Train-parted signal to the enginemen.

20. Signalmen must have the proper appliances for hand signaling ready for immediate use. Hand signals must not be used when the proper indication can be displayed by the fixed signals. When hand signals are necessary they must be given from such a point and in such a way that there can be no misunderstanding on the part of enginemen or trainmen as to the signals, or as to the train or engine for which they are given.

21. If necessary to discontinue the use of any fixed signal, hand signals must be used and the Superintendent notified.

22. Signalmen will be held responsible for the care of the interlocking station, lamps and supplies; and of the interlocking plant, unless provided for otherwise.

23. Lights in interlocking stations must be so placed that they cannot be seen from approaching trains.

24. Lights must be used upon all fixed signals from sunset to sunrise, and whenever the signal indications cannot be clearly seen without them.

25. If a train or engine over-runs a stop signal, the fact, with the number of train or engine, must be reported to the Superintendent.

26. Only those whose duties require it shall be permitted in the interlocking station.

Enginemen and Trainmen.

27. A signal imperfectly displayed, or the absence of a signal at a place where a signal is usually shown, must be regarded as a stop signal and the fact reported to the Superintendent.

28. Trains or engines must be run to, but not beyond a signal indicating stop.

29. If a clear signal, after being accepted, is changed to a stop signal before it is reached, the stop must be made at once. Such occurrence must be reported to the Superintendent.

30. Hand signaling includes the use of lamp, flag, torpedo and fusee signals.

31. Enginemen and trainmen must not accept clear hand signals as against fixed signals until they are fully informed of the situation, and know that they are protected. Where fixed signals are in operation, trainmen must not give clear hand signals against them.

32. The engineer of a train which has parted must sound the whistle signal for Train-parted on approaching an interlocking station.

33. An engine receiving a Train-parted signal from a signalman, must answer by the whistle signal for Train-parted.

34. When a parted train has been re-coupled, the signalman must be notified.

35. Sand must not be used over movable parts of an interlocking plant.

36. Conductors must report to the Superintendent any unusual detention at interlocking plant.

37. Trains or engines stopped in making a movement through an interlocking plant, must not move in either direction until they receive the proper signal from the signalman.

38. Passenger trains must not exceed a speed of 12 miles, and other trains a speed of 8 miles per hour over interlocked railway crossings, junctions and draw bridges.

Signal Repairmen.

39. Repairmen are responsible for the inspection, adjustments and proper maintenance of all the interlocking plants, highway crossings, bells, etc., assigned to their care.

40. Where the condition of switches or track does not admit of the proper operation or maintenance of the interlocking plant, the fact must be reported to the Superintendent.

41. When any part of an interlocking plant is to be repaired, a thorough understanding must be had with the signalman, in order to secure the safe movement of trains and engines during repairs. The signalman must be notified when the repairs are completed.

42. Alterations or additions to an interlocking plant must not be made unless authorized by the Superintendent.

43. Repairmen when on duty, or subject to call, must keep the proper officer advised as to where they can be found, and respond promptly when called.

LIST OF TOOLS FOR SIGNAL REPAIRMEN.

1 portable forge 20x30-in. fire box, 10-in. fan blower, no hood.
1 150-lb. anvil.
1 pipe cutter to cut ½-in. to 1-in. pipe.
2 dies for 1-in. pipe.
1 die for ¾-in. pipe.
1 pipe stock for above dies.
2 1¾-in. adjustable pipe tongs.
1 ⅝-in. round file.
1 12-lb. sledge and handle.
1 canvas tool bag.
1 No. 5 Champion drill press three geared 20-in. swing with ⅝-in. straight hole for drill in shaft.
1 No. 2 Westcott's Little Giant drill chuck with ⅝-in. shank jaws to hold up to 1 in.
500 feet ¾-in. Manilla rope.
1 double block for ¾-in rope.
1 single block for ¾-in. rope.
1 Stillson wrench, 14-in.
1 reamer, ⅞-in.
2 14-in. flat files.
1 ¼-in. round file.
1 ratchet drill.
1 combination pipe vise to hold up to 2-in. pipe, jaw to be 4-in. wide.

2 1/4-in. Twist drills, 5/8-in straight shank.
2 3/8-in. Twist drills, 5/8-in straight shank.
2 5/8-in. Twist drills, 5/8-in. straight shank.
2 11/16-in. Twist drills 5/8-in. straight shank.
2 13/16-in. Twist drills, 5/8-in. straight shank.
2 7/8-in. Twist drills, 5/8-in. straight shank.
2 1 1/16-in. Twist drills, 5/8-in. straight shank.
2 1 1/4-in. Twist drills, 5/8-in. straight shank.
2 11/16-in. Twist drills for rachet square shank.
2 13/16-in. Twist drills for rachet square shank.
1 pair 1 3/4-in. round blacksmiths tongs.
1 pair 3/4-in. round nose blacksmiths tongs.
2 pair 1 1/4-in. flat nose blacksmiths tongs.
1 1 1/4-in. top swage.
1 1 1/4-in. bottom swage.
1 hot chisel and handle.
1 cold chisel and handle.

Signaling Practice*

This Committee was appointed four and a half years ago, making its first report in October, 1906. For four years, therefore, it has been constantly engaged on the subject assigned to it, and has given it more study than is usually expended on matters of this nature. Of the original Committee eight are still members, while two of the remaining four are associated with it as members of Committee No. 10, of the A. R. E. & M. W. Association. Eight men have been added, thus entirely changing the original make up, and yet the report is identical in many essential details with that presented four years ago. A comparison of diagram No. 2, page 176, Vol. III. with Exhibit No. 2, of the present report, will be entertaining as well as instructive.

We have, during our four and one-half years' study of the problems before us, considered a great number and variety of suggestions, and particularly during the past year, schemes two and three, so called, which were officially presented to the Association last March, and neither of which the Committee is prepared to endorse or recommend for the following reasons:

It was proposed to indicate limited speed by the 45-degree position of the arm and to use the second arm as a repeater of the three positions of the top arm on the next signal in advance. The Committee, however, was unable to see any considerable advantage in this scheme and believes that the aspects presented, which use the same number of arms and positions, are much less at variance with present practice than those proposed, and, other things being equal, the less change from present practice the better. The proposed assignment of the 45-degree position of the arm to the indication, Proceed at limited speed, seemed to the Committee, in effect, a radical change from present practice. It was contended that the indication in question is practically unknown at present, and that the use of the 45-degree position for this new indication could not, therefore, involve a greater change from present practice than the use of the second arm for the same purpose. The Committee, however, feels that the new indication is merely a definite wording of the indication actually given by the second arm of numerous interlocking signals at the present time, and that the aspects recommended are, therefore, in this respect, decidedly in line with present practice. On the other hand, the Committee's use of the 45-degree position of an arm to indicate the specific restriction, "prepare to stop at the next signal," as a qualification of the indication given by the 90-degree position of the same arm, is entirely in accord with common practice in the case of three-position automatic block signals and with the practice of one or more roads in the case of interlocking signals. While this position is also extensively used for the "permissive block" indication, the Committee simply proposes to confine it to one of two indications for which it is now used indiscriminately.

There is an honest difference of opinion in the Committee as to the Requisite Indications and a very substantial majority believe that present practice should be followed as closely as possible consistently with uniformity, it being taken for granted that our operating officers are not as a rule giving useless information to their enginemen. In fact, the entire tendency of the American Railway Association in its Standard Code is to eliminate all useless verbiage in its train orders, and leave only the essence. Similarly it can well be presupposed that the indications and aspects in common use are required.

The Committee was confronted on the one hand by the demand for conveying a vast amount of information not heretofore given, and on the other, by a similar demand for simplicity of aspects, even at the cost of elimination of necessary indications. It has, it believes, taken a middle ground and while providing all the information which is necessary and advisable for the safe and proper operation of a large and com-

*Report in part of Committee No. 1 of the Railway Signal Association.

Basis of Primary Indications.	Primary Indications.	Secondary Indications.
Control of the Train Immediate Stop — including or not including action to be taken after stopping. Proceed Because of the indicated absence of restriction at the point where the indication is given but not in disregard of a restriction previously imposed; the control indicated, for example, when a main track switch is normal or a block station is closed. As a specific name for the indication the word "Continue" is proposed. Because the restriction imposed by a slow sign, but no other restriction, is here removed. Without or with restriction of speed to be observed at the point where the indication is given. Future After the immediate control indicated in a given case, preparation: To stop at next signal; To pass next signal at limited speed; To stop at any point.	Stop 1. Stop 2. Stop—then proceed (Rule 504) 3. Stop and investigate. Proceed 4. Continue. 5. Resume speed. 6. Proceed. 7. Proceed—prepare to stop at next signal. 8. Proceed—prepare to pass next signal at limited speed. 9. Proceed—prepare to stop short of any obstruction in the block. 10. Proceed at limited speed. 11. Proceed at limited speed—prepare to stop at next signal. 12. Proceed at limited speed—prepare to stop short of any obstruction in the block. 13. Proceed at low speed. 14. Proceed at low speed—prepare to stop.	15. Get orders 16. Take siding. 17. Stop for passengers (Flag Stop) 18. No passengers Note— Indication No. 4 may be given by main track switch signals, block signals when block station is closed, signals at interlocking stations that are not block stations where permissive block is used, and train-order signals when there are no orders.

Exhibit No. 1—List of Indications Recommended by Committee No. 1.

RAILWAY ENGINEERING AND MAINTENANCE OF WAY.
BRIDGES-BUILDINGS-CONTRACTING-SIGNALING-TRACK

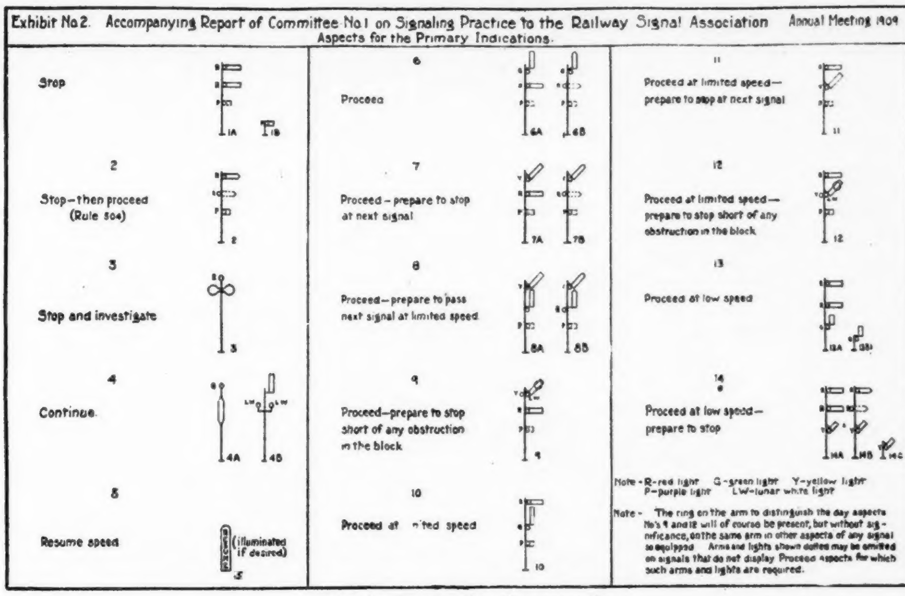


Exhibit No. 2—Signaling Practice.

plicated railroad system, has supplied a path (Exhibits Nos. 3 and 4) by which the roads of thin traffic can, while signaling safely and sufficiently for their needs, lead up to a uniform system without loss of material and labor during the transition stage, the progress being gradual but constant. As stated in one of its former reports not revolution, but rather evolution is desired and intended.

The Committee has attempted to codify the indications now in general use, and provide uniform aspects for them rather than to eliminate many (on the ground that they are unnecessary) and "simplify" the system by making it incomplete.

While it may appear that the Committee has gone much further and formulated indications not now used and not required, due consideration will show, it is believed, that, in nearly every case, what has really been done is merely to express in words the action taken in response to certain signal aspects now in use and generally admitted to be necessary. In point of fact, not an indication is submitted by the Committee that is not now given, either in definite terms or by general understanding, on one or more roads, and with one or two exceptions on most roads.

The Committee therefore recommends that each member of the Association canvas the situation carefully on his own road, and be prepared to discuss the table of indications on the basis of his own road's present and future needs.

In 1907 the table of sixteen requisite indications was submitted to the American Railway Association Joint Committee, which took no definite action, and has since been superseded by other committees. During the intervening two years' study, some few changes have been made, and Exhibit No. 1, herewith, represents, we believe, the irreducible minimum required by complete modern operating conditions.

If the American Railway Association should later decide, in its wisdom, that more indications are required, the system we present forms a basis for a few additional aspects. If, on the other hand, it decides that less are needed, those not required by users of the Code, may be eliminated, while those roads feeling the need of them, are provided with the machinery for

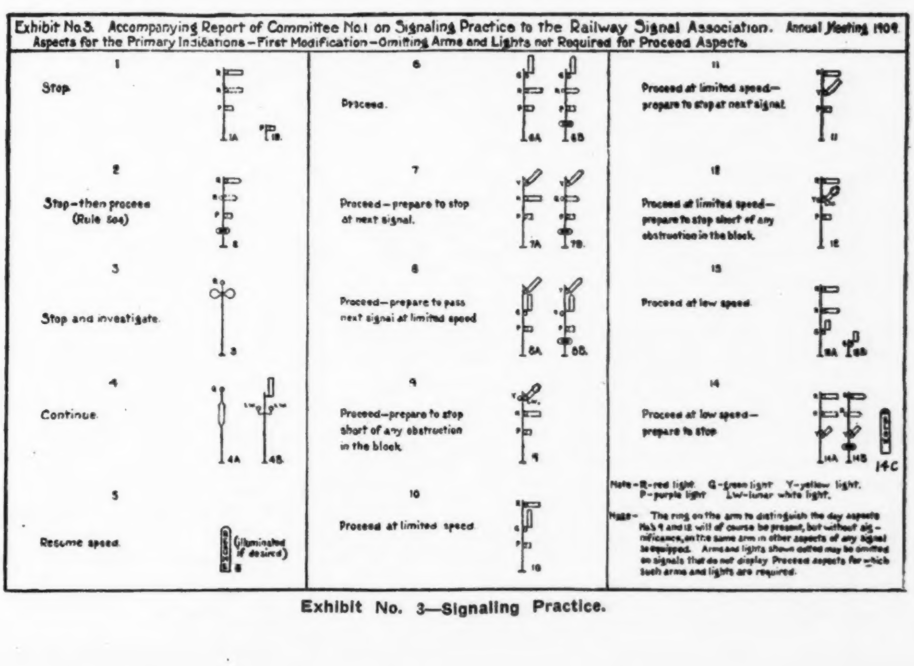


Exhibit No. 3—Signaling Practice.

RAILWAY ENGINEERING AND MAINTENANCE OF WAY. BRIDGES—BUILDINGS—CONTRACTING—SIGNALING—TRACK

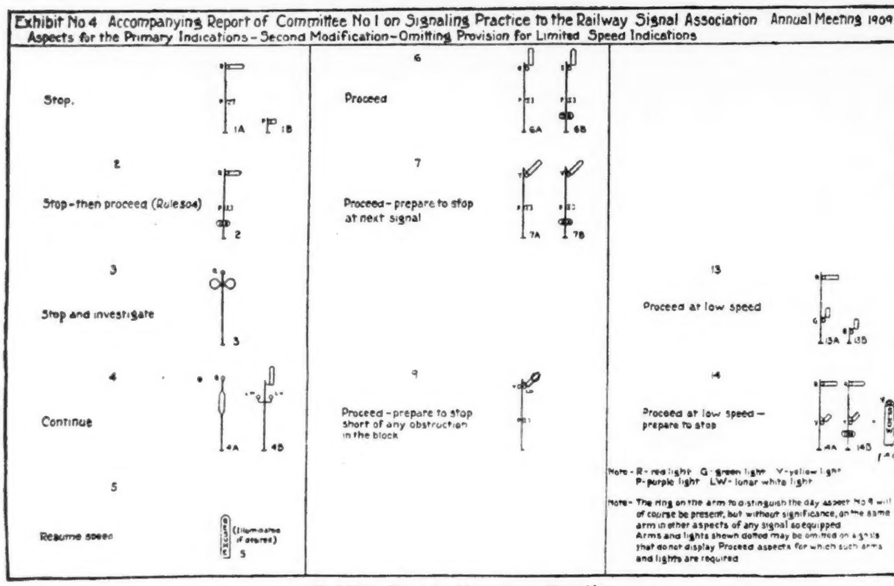


Exhibit No. 4—Signaling Practice.

their display; this, in the minds of the Committee, being preferable to presenting a system so designed as to be incapable of expansion along logical and natural lines.

PRIMARY INDICATIONS.

Of the three Stop indications it is sufficient to say that it is believed to be common in present practice to make equivalent distinctions in the aspects more or less clearly; that the action required is distinctly different in each case; and that it is therefore right so to word the indications as to define the proper action.

No. 1, Stop, without qualification, obviously leaves the trainmen no alternative but to remain until authorized to proceed; No. 2, Stop—then proceed (Rule 504), specifies briefly the regular procedure in the case of automatic block signals; under No. 3, Stop and investigate, the trainmen are left to deal with the situation themselves, set an open switch normal or ascertain if a signal is improperly displayed, and proceed when they are satisfied that it is safe to do so.

Indications No. 4, Continue, and No. 5, Resume Speed, are sufficiently explained in the first column of Exhibit No. 1.

Indication No. 6, Proceed, is the most favorable indication of any signal that may give indication No. 1 or No. 2, involving no restriction that might be indicated by that signal.

In case of indication No. 7, Proceed—prepare to stop at next signal, it is assumed by the Committee that, if two signals that may give indication No. 1 or No. 2 are located within "stopping" distance of each other, the first should give an "approach" indication for the one in advance; that is, a manual block or interlocking home signal should give indication No. 7 when the advance signal, if there is one (manual or automatic), is at stop; and so on. While this is not yet common practice it is the practice on some roads and, in the opinion of the Committee, is to be recommended.

It is further assumed that indication No. 7, under the conditions stated, includes clear track to the next signal; the only restriction imposed is that providing for a stop at the next signal. The indication, with a change of wording for the sake of uniformity, is therefore, in effect, the same as that given in the Standard Code for one position of a three-position automatic block signal (approach next home signal prepared to

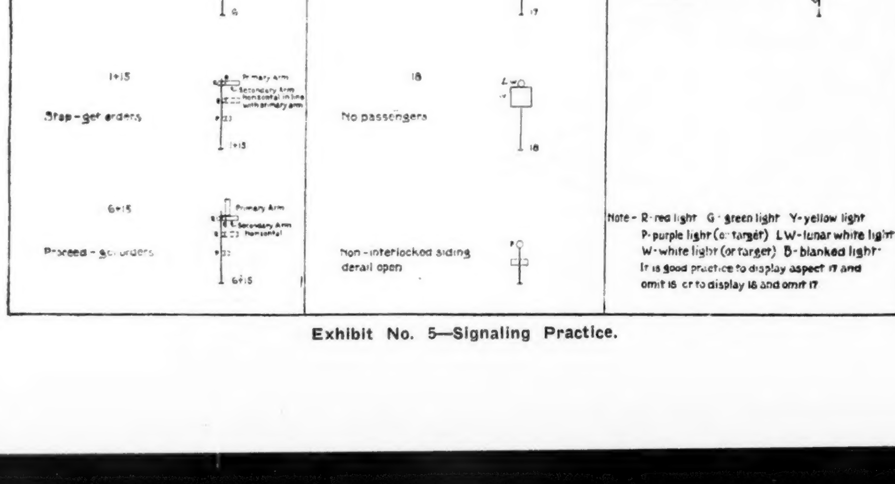


Exhibit No. 5—Signaling Practice.

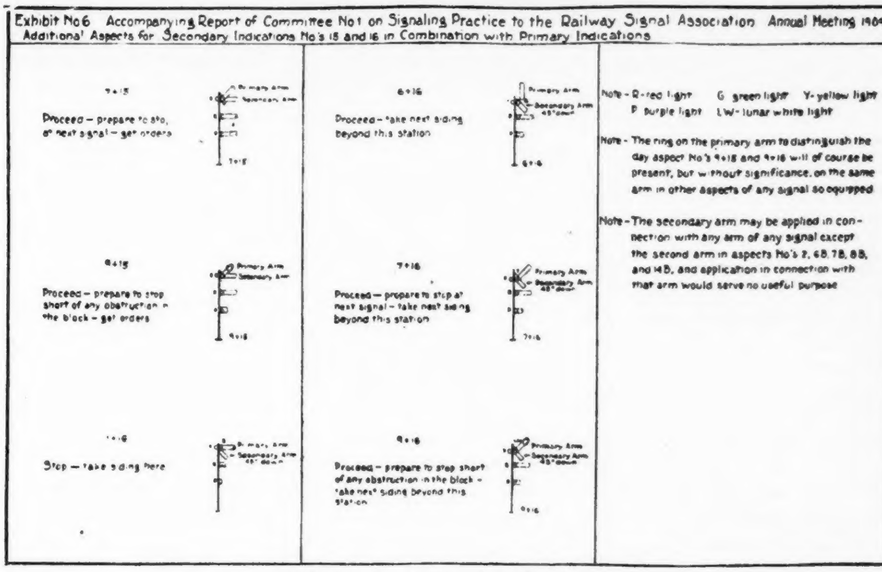


Exhibit No. 6—Signaling Practice.

stop). In the case of an outlying distant signal it is simply a matter of choice whether indication No. 2 (or possibly No. 1) shall be given when a train is between the distant and home (the present practice on one or more roads), or indication No. 7 shall not positively assure clear track from such signal to the home signal, the condition of that portion of the track being indicated by, or at, a preceding block signal on block-signaled roads.

Indication No. 8, Proceed—prepare to pass next signal at limited speed, is a definite wording for the indication now practically given in numerous instances by the second arms of two-arm distant signals, and is deemed necessary if full advantage is to be derived from the indication of three gradations of speed at home signals.

Indication No. 9, Proceed—prepare to stop short of any obstruction in the block, is believed to be a better wording, following closely that of the Caution Card in the Standard Code, for the "permissive block" indication numbered 19 in the report of 1908, and there placed under the heading, "Secondary System." It is felt that, as this is an indication directly governing the movement of trains, it should be included among the primary indications. The Committee believes that it will be supported by many railway officers in the view that this indication is so different from No. 7, or still more from No. 10, in the character of the instructions given to the enginemen and the handling of the train required, that different indications and aspects are needed for consistent signaling.

Indication No. 10, Proceed at limited speed. It is hardly necessary to elaborate on the lack of uniformity that has prevailed in the significations of the different arms of interlocking home signals. After an exhaustive study of the subject the Committee became convinced that, in a consistent and universally applicable system of signaling, the safe speed at which the turnouts or crossovers set up in a given case could be taken, should be indicated in a uniform manner by the signals; and that it is wholly impracticable to provide for the intelligible indication of individual routes in all situations, by semaphore signals. The conclusion of the Committee is concisely expressed as follows:

"That, inasmuch as interlocking signal plants are introduced to make the passage of trains safe at speed over track layouts more or less complicated by crossovers, turnouts and crossings, the object in arranging interlocking signals is primarily to indicate *routes* for trains, and secondarily, as a necessary consequence, *speeds* for trains." The Committee also concluded that three gradations of speed could successfully be indicated by semaphore arms. Indication No. 6, Proceed, permits unlimited speed so far as the signal indication is concerned, subject, of course, to such general limitation as may be in force at a particular point. For the next, or intermediate, rate the Committee proposes the phrase "limited speed," and for the third, "low speed."

It is obvious that the idea of "speed signaling" may be expanded to include the indication by signal of reduced speed made necessary by conditions other than movement over turnouts or crossovers, but it is also clear that the latter condition will always be a prominent occasion for such indications. Under indication No. 10 as relating to passage over turnouts or crossovers, safe movement will evidently be secured if the train maintains, but does not exceed, the specified speed when passing the signal and until it is beyond the switches. In practice the distance to be traveled at limited speed might be defined by a signal in advance, the Proceed indication of which would cancel the limited-speed indication of the first signal, or might be prescribed by rule, the distance fixed being sufficient to cover any series of turnouts or crossovers to be met with. In any case, however, with due regard for both safe and expeditious train movement, it must be conceded that the indication, Proceed at limited speed, without added qualification, will be fully carried out if the train keeps up to the specified rate of speed to the next signal.

Indication No. 11, Proceed at limited speed—prepare to stop at next signal, and No. 12, Proceed at limited speed—prepare to stop short of any obstruction in the block, are qualifications of No. 10, formed in exactly the same way as Nos. 7 and 9 are formed from No. 6, and seem to need no further explanation than that given in connection with those indications.

Indications No. 13, Proceed at low speed, and No. 14, Proceed at low speed—prepare to stop, are recommended with a view to expediting train movement. No. 13, like No. 10, imposes no restriction other than maintenance of the specified speed for a distance prescribed by rule or defined by a signal in advance which must then give some Proceed indication; if it indicated Stop, indication No. 14 would be given at the first signal. Indication No. 14 imposes the greatest restriction; not only low speed which may be necessary for safe movement through short turnouts or crossovers, but preparation to stop because of possible obstruction ahead or because the route may lead to a short spur or a siding blocked with cars.

It is hardly necessary to say that indication No. 13, like sev-

eral others in the list, would not be used at all on a road on which it was felt that the advantage would not justify provision for displaying the aspects; it seems to the Committee proper, however, to recommend a sufficient number of primary indications to provide for all operating conditions with which it was familiar.

SECONDARY INDICATIONS.

Indications No. 15, Get orders, and No. 16, Take siding, it will be noted, replace four indications in the table accompanying the report of 1908. In the case of the indication for orders the Committee recognized a demand for consistent means of giving these indications in connection with block and interlocking signals, in place of flags and lamps displayed at the station on many roads at present. On further consideration, however, it appeared that the requirement is, not to indicate by signal whether 31 or 19 orders are to be received, but to indicate whether the train shall stop for orders (31 orders) or may proceed and pick up orders (19 orders). It follows that a single secondary indication, Get orders, should be sufficient as, if it is given in connection with a primary Stop indication, the meaning will be, Stop—get orders, and in connection with any Proceed indication, Proceed—get orders.

The Take-siding indication may be given by a separate signal (No. 16, exhibit No. 5) located at or near the switch to be used, or by suitable means at a block station, when the train may be required to take the siding adjacent to the station or the next siding beyond that station. In either case, one secondary indication seems to the Committee sufficient as, in the second case, the primary indication in connection with which the Take-siding indication is given, will determine which siding is intended; that is, if Stop is indicated, the train must take siding "here" as it has no authority to proceed in the block, while, if any Proceed indication is given, the train may proceed in the block to the next siding beyond the station and take siding there.

Indications Nos. 17 and 18 are inserted as a basis for aspects which it seemed desirable for the Committee to provide in order to avoid conflict with the other aspects of its recommended system.

PRIMARY ASPECTS.

Exhibits Nos. 4, 3 and 2, in that order, are designed to show how a road with few requirements may be signaled without conflict with the Committee's recommended completed system and may be in position, as its increasing requirements warrant, to develop in an orderly manner to that system. It is assumed that, in the first stage, as there will be few interlockings, limited-speed indications will be unnecessary. As interlocking increase in number and limit-speed indications become desirable, it will be a good practice to use the necessary arms and lights on signals giving those indications and omit them on other signals. Finally, as the number of "active" arms increases and the advantages of uniform two-light signaling are more fully appreciated, the necessary fixed arms and lights may be added to round out the complete system shown on Exhibit No. 2.

SECONDARY ASPECTS.

In submitting the aspects for secondary indications No. 15, Get orders, and No. 16, Take siding, and their combinations with primary aspects, Exhibits Nos. 5 and 6, the Committee feels that practical and intelligible aspects are offered and that those shown on Exhibit No. 5 provide for the indications recommended. As some roads, however, might wish to give the other primary indications in connection with Get orders or might wish to give the Take-siding indication on a block signal, and as the 45-degree downward position of the secondary arm was available, the Committee deemed it proper to submit the additional aspects, Exhibit No. 6, to be used if desired.

It should be noted that, in both sets of "combination" aspects (Exhibits Nos. 5 and 6), the "primary" arm always takes the same position and has the same color of light to the right of the mast for a given primary indication as in the simple primary aspects; and the "secondary" arm is always down vertically, with no light to the left of the mast, when no secondary indication is given, 45 degrees downward, with a purple light, for the Siding indication, and horizontal, with a red light, for the Order indication, whatever the position of the "primary" arm.

The yellow light to the left of the lunar white in aspects Nos. 9 and 12 is independent of a "secondary" arm (which may or may not be present) and is provided for contrast with the lunar white in the case of these main-track governing aspects; the red and purple lights in aspects Nos. 9+15 and 9+16 serve the same purpose in addition to giving the secondary indications.

It is to be understood that the secondary arm and light, shown at the top of the mast on Exhibits Nos. 5 and 6, may be applied in connection with any arm of any signal (except the second arm of an automatic block signal, where they could serve no useful purpose).

The Committee shows two simple aspects for flag-station signals sufficiently different from any other main-track signal aspects recommended, to make confusion impossible. Some roads use aspects for both indications; others display a signal only when there are passengers, and, for the sake of eliminating one aspect, satisfactory results might also be obtained by displaying a positive signal when there are no passengers, and no signal when there are passengers, with the requirement that trains scheduled to stop should not pass the station in the absence of the aspect indicating No passengers. The Committee is of the opinion that either of the three plans would be good practice, as no question of safe train movement is involved.

It seemed proper to submit uniform aspects for siding switches and derails (Exhibit No. 5), which explain themselves; but hardly necessary to include the indications on Exhibit No. 1.

The Committee therefore presents Exhibits Nos. 1, 2, 3, 4, 5 and 6 and recommends the adoption of the following conclusions:

1st. That the indications, Exhibit No. 1, are adequate; permit of a uniform system of signaling; are not in conflict with existing systems, and are recommended to the American Railway Association for approval.

2d. That the Primary Aspects, Exhibit No. 2, are practicable; form an adequate and proper basis for the display of the Primary Indications; provide an excellent means for attaining a uniform, universal system of signaling; and are therefore endorsed by this Association, and submitted to the American Railway Association for such action as may be necessary to enable roads desiring to use them to do so with the approval of that Association.

3d. That Exhibit No. 4 provides a simple means of signaling; adequate for the needs of many roads and branches, and is a proper method of signaling which, while not providing for uniformity, may be developed through the scheme shown on Exhibit No. 3 into the complete system, Exhibit No. 2. The outlines shown on Exhibits Nos. 3 and 4 are therefore endorsed by this Association and submitted to the American Railway Association for such action as may be necessary to enable roads desiring to use them to do so with the approval of that Association.

4th. That the secondary aspects, Exhibit No. 5, form a simple and proper means of conveying certain necessary instructions, and are therefore endorsed by this Association and submitted to the American Railway Association for such action as may be necessary to enable roads desiring to use them to do so with the approval of that Association.

5th. That the additional secondary aspects in combination with primary aspects, Exhibit No. 6, are suitable and proper aspects for use where desired, and are therefore endorsed by this Association and submitted to the American Railway Association for such action as may be necessary to enable roads

desiring to use them to do so with the approval of that Association.

The indications are given by blades operating in the upper **right-hand** quadrant, as in previous reports. The use of the upper left-hand quadrant was discussed at the New York meeting of the Association on June 8th and was referred to the Committee, and vote upon its importance had only begun to arrive at the last meeting of the Committee, July 20th. It was therefore found necessary to postpone consideration of this subject until later. To date (August 14th) the result of the ballot is as follows, 147 for further consideration, 105 against further consideration.

At the meeting of the Committee, July 21, 1909, it was voted that the Chairman of the Sub-Committee on aspects be requested to obtain and submit with the report an opinion from the official occulist of the American Railway Association in regard to the practicability of the use of lunar white light and the probable result of elimination tests of locomotive engineers for indistinct color perception. The Chairman of the Sub-Committee has been in communication with Doctor A. G. Thomson, official occulist of the American Railway Association, who has kindly consented to make a number of tests, and it is expected that a verbal report on results will be submitted to the Association in October.

Respectfully submitted, A. H. Rudd, Chairman; C. C. Anthony, H. S. Balliet, H. S. Cable, C. A. Christofferson, C. E. Denney, W. J. Eck, W. H. Elliott, M. H. Hovey, A. S. Ingalls, J. C. Mock, F. P. Patenall, J. A. Peabody, H. H. Temple. Not concurring, L. R. Clausen, T. S. Stevens.

MINORITY REPORT.

The undersigned cannot support the scheme for Uniform Signaling, recommended in this report, for the following reasons:

1. Two of the four principles upon which it is based have been accepted without full investigation.

(a) The 45-degree position of the arm shall indicate the position of the next signal in advance.

(b) The location of the arm on the mast shall indicate the speed at which the movement shall be made.

2. The scheme has too many indications and aspects, which are difficult to remember and understand and will be confusing to the train and enginemen.

3. While a multiplicity of aspects is provided they are incomplete. The operation of railroad signals today is based upon the principle that the absence of a signal where one is usually displayed shall indicate Stop. For example: Indication No. 7 (Proceed—prepare to stop at next signal) is equivalent to saying, "Proceed, the next signal is in Stop position." The absence of the 45-degree position or change to the 90-degree position gives the engineman permission by inference to assume that the next signal is clear, but this is not covered by an indication. The same criticism applies to other similar indications. In other words, in order to complete a system of signals along the lines presented it is necessary to provide additional indications.

4. There is no well defined basic principle that may be followed in interpreting the aspects. The scheme has many interpretations which are not covered by, or in harmony with, the Standard Code.

5. The scheme provides specific information about conditions in advance; notably, the indication of next signal. The **Distant** signal is used as a repeater of the Home and is bound to teach enginemen to relax vigilance and depend upon advance information which is subject to change, and, therefore, unreliable. The plan of providing repeaters for Home signals will eventually lead to a demand for still further repeaters and checks of various kinds upon fixed signal systems, such as cab signals, and ultimately automatic stops, all of which tend to a laxity in the proper degree of attention on the part of employees.

6. There are too many red lights displayed.

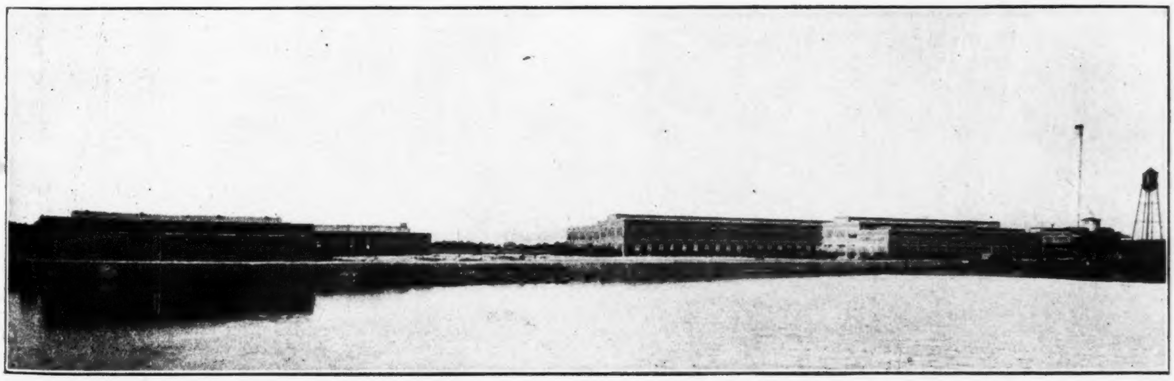
7. The same aspects are used for different indications and different indications for the same aspects.

8. Definite or precise information of considerable variety not required in the practical operation of a railroad is provided throughout the scheme. In order to maintain the distinctions much complication is introduced which may lead to considerable difficulty. For example: Instead of one Caution signal there is provided a special signal for each of the several occasions requiring caution. By T. S. Stevens and L. R. Clausen.

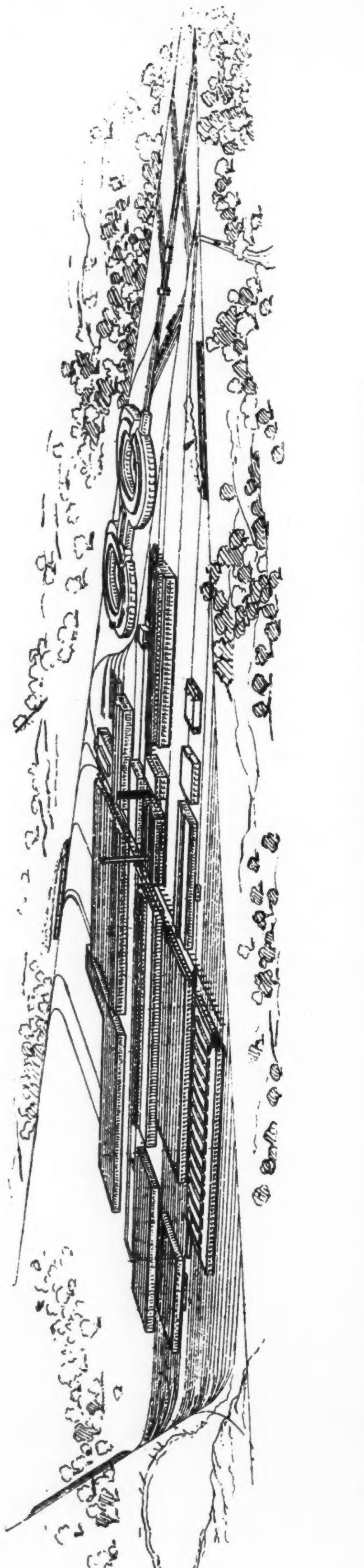
Springfield Shops, St. Louis & San Francisco Railroad

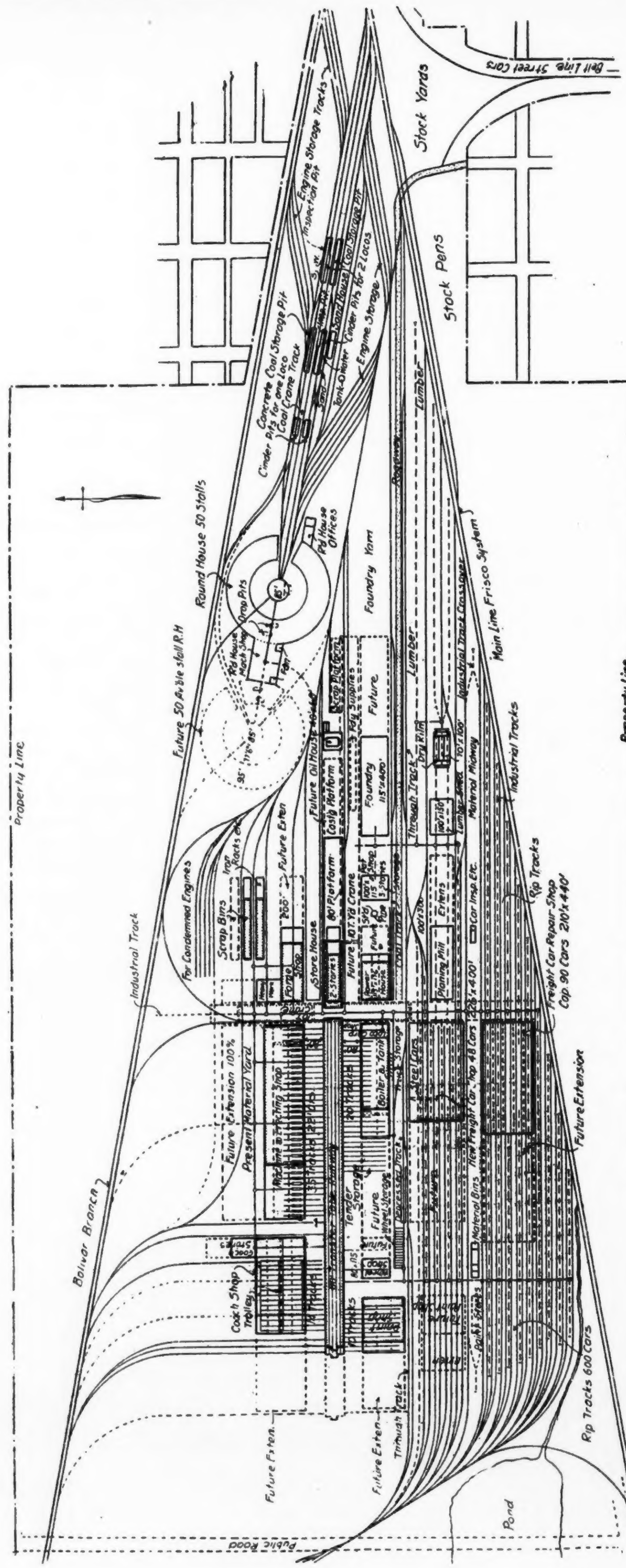
The car and locomotive shops of the St. Louis & San Francisco Railroad at Springfield, Mo., were recently completed and opened for service. There have been some changes in the plans since the layout was designed, two years ago, as is natural, but the photographs, published herewith, show that the buildings generally are constructed according to the ideas expressed in the original plans.

The Arnold Company of Chicago were the engineers and constructors of the complete shops; Mr. P. L. Battey, chief engineer of the Railway Shops Department of this firm, having personal supervision of both design and construction. The plans were worked up in co-operation with Mr. W. A. Nettleton, who was at that time general superintendent of motive power; Mr. George A. Hancock, superintendent of motive power, and Mr.



General View of Springfield Shops, Cooling Pond in Foreground.





Birdseye View and Ultimate Shop Layout.

M. C. Byers, chief engineer of the St. Louis & San Francisco Railroad. Mr. C. R. Gray, vice-president, has taken personal interest in the work throughout, and to him all plans were submitted for final approval.

Arrangement of Present and Ultimate Plant.

The arrangement of the plant provides convenient grouping of the buildings included in the present construction. The growth of these and the addition of future departments will not in any way detract from its arrangements and such additions will be built as economically located from every operating standpoint as in the original plan. The buildings common to each department are located in the heart of the plant. These consist of the store house, power house and blacksmith shop.

The store house is convenient to the locomotive department, future round houses and future freight car department, and by means of the transfer table, easy access to the coach department is provided. It is immediately opposite one end of the transfer table and near the center of the yard crane runway so that material can be conveniently collected from or delivered to any building on the ground.

One of the striking features is well worth noting here: Every department can be increased about 300 per cent without unduly extending the lines of travel for men and material. This result was obtained only by a very careful study of the problem. Three hundred per cent extension is an unusual feature but is necessary in this instance owing to the combining of the two old plants now being operated, with the new one, and in addition allowing for a possible further extension of 100 per cent of the present plant before this consolidation of the plants is accomplished.

The power house is in the center of gravity of the power requirements, being close to the machine and erecting shop, boiler and tank shop, and adjacent to the future planing mill, from which waste material may be delivered directly to the boilers. The blacksmith shop is close to the machine and erecting shop, scrap bins and future round houses, and by means of the yard crane, close to the future freight car department, via the transfer table, or by industrial tracks, it is accessible to the coach department, where the least output is required.

The tracks on the shop site are conveniently arranged for the receiving of all material, intercommunication of different departments, and for the removal of the output. A "Y" track is provided close to the machine and erecting shops, leading from one serving track on to the transfer table, for the purpose of turning engines.

The present machine and erecting shop and boiler and tank shop are served by the transfer table, which is common both to the locomotive and coach departments. This makes a very economical design up to the limit provided in the layout; future extensions being accomplished without material increase in the length of the transfer table pit.

The coach repair shop is convenient to the coach paint shop, and by means of the transfer table and industrial tracks, sufficiently convenient to the locomotive department for such material as will be furnished from this source.

The future freight car department is conveniently grouped in that the freight car repair shop and the new freight car shop are both convenient to the planing mill and lumber yard; material entering yard from the east, passing through the dry kiln, dry lumber storage planing mill, new freight car shop and new freight car paint shop, in continuous unidirectional movement to completion.

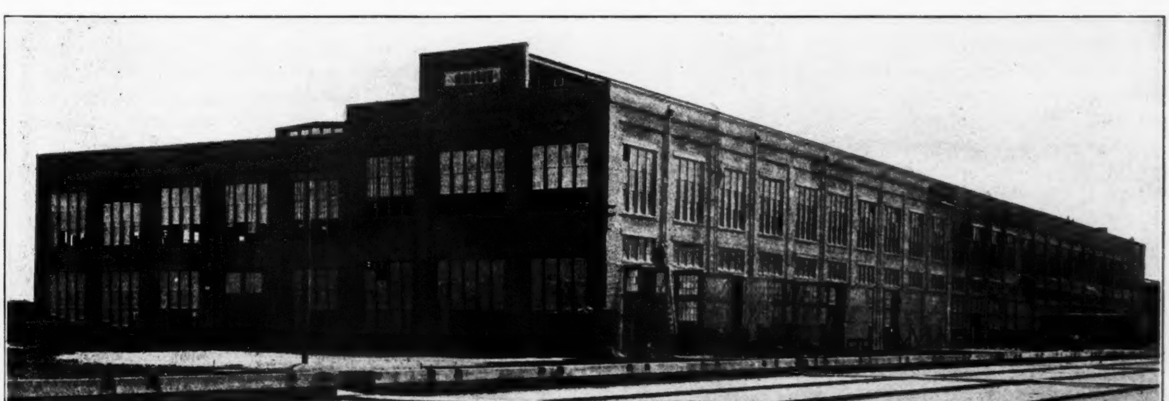
The future steel car shop is adjacent to the new freight car shop, making it convenient to composite cars, and is also close to the present boiler and tank shop, thus bringing this class of work close together, the area between the latter two buildings serving as a general material yard for both departments. The steel cars will pass directly through the new freight car paint shop on the way out. The future car wheel shop is located as nearly central as possible to the freight car and coach shops by means of the transfer table and industrial tracks, providing for the handling of wheels to and from these shops and which can be efficiently accomplished. The future pattern shop is located close to the future planing mill and lumber yard, also adjacent to the future foundry, which is so located that raw material will enter from the east and pass through the departments in continuous movement. Provision is made for a future crane between the foundry and store house platform, which will provide an economical means of handling foundry supplies and finished castings.

The future oil house will be convenient to the store department and the future roundhouse, to which it is most closely related. Other departments are not inconveniently far removed from it. The future roundhouses are located convenient to the road and also to the shop, and the future engine handling facilities will be conveniently grouped for rapid and economical handling of locomotives. Areaways are provided between tracks and buildings for the storing of material and for general accessibility about the plant, particular attention being given to the elimination of all possible fire hazard.

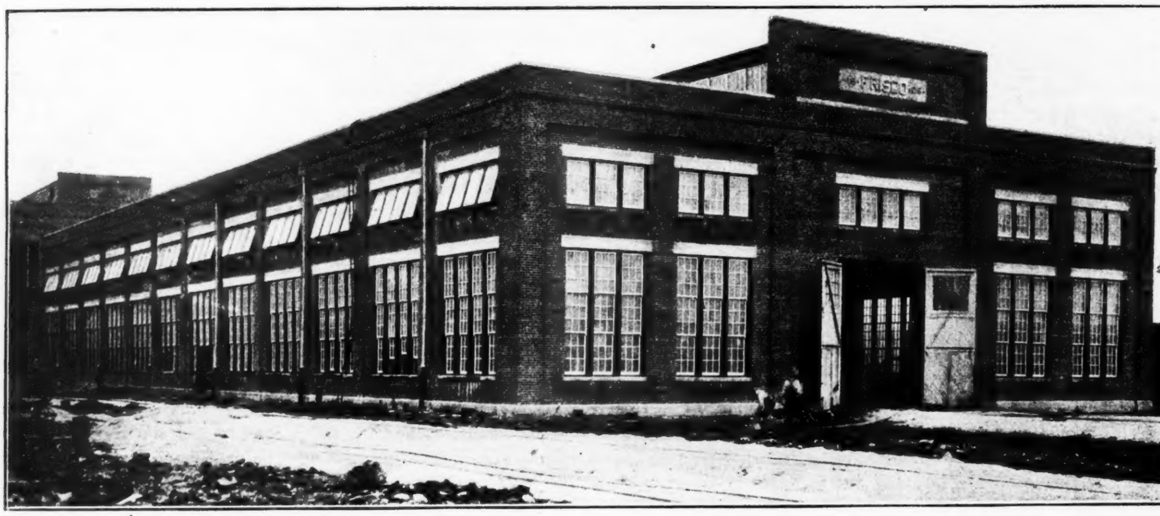
Capacity of Present Plant.

The normal capacity of the present locomotive department is 35 to 40 engines per month. The erecting shop contains 25 working pits. Tributary departments are in proportion. The possible ultimate capacity which can be conveniently provided is 90 pits. The present coach repair shop has a capacity of about 35 coaches per month, being provided with floor space for 22 coaches.

The coach paint shop and other tributary departments are provided in proportional capacity. Three hundred per cent future extensions of this department is provided and even more can be obtained if ever desired, although the possibility of the latter is questionable. Under normal operating conditions the two departments will employ about 800 or 900 workmen.



Locomotive Machine and Erecting Shop, Springfield Shops.



Blacksmith Shop, Springfield Shops.

General Description of Buildings.

The buildings throughout are of brick, steel and reinforced concrete. The only inflammable material used is heavy three-inch plank on the ground floors; heavy roof sheathing on the shop buildings, and the window frames and doors. The store house and platform, oil tanks and pump houses are of reinforced concrete throughout, and the power house has reinforced floors and roof.

All buildings, except the storehouse, have self-supporting structural steel frames, with hard brick curtain walls, and all window openings are glazed with one-eighth inch factory ribbed glass. Particular study has been made of the lighting of all the buildings and the result is immediately evident to all observers. An average of one-third of a square foot of window area is provided for every square foot of floor space. All buildings have parapet walls three feet high above roofs, and the roofs throughout are of 5-ply tar and gravel composition. This design materially reduces the fire risk.

The coach repair and coach paint shops have roofs and sawtooth construction, providing north light over the entire area of buildings. Sawtooth glazing is of one-fourth inch ribbed wire glass. Cast iron ventilators with adjustable dampers are provided in sufficient numbers to insure the proper ventilation of these buildings. The machine and erecting shop, boiler and tank shop, blacksmith shop and power house, are well provided with roof monitors of ample dimensions, giving both excellent interior lighting and good ventilation.

The Store House and Office Building.

This building is in the exact center of the entire plant. It is 61 feet wide and 162 feet long; it is two stories high, the ceilings being very high to provide for the storing of materials in as economical a manner as possible.

A concrete platform extends entirely around the building for outside storage of heavy supplies and as a means of handling materials. This platform is 90 feet wide by 248 feet long and is raised 4 feet above the ground so that cars will open directly upon it. The floor space within the building is 18,500 square feet; on the platform 12,600 square feet. The cubical contents of the structure is 286,000 feet.

The first floor is largely divided for store house purposes, but it also contains a centrally located office for the storekeeper, and in the west end of the building is the general timekeeper's office for the plant.

The second floor is divided into two sections for offices and store rooms. The office section is in the west end of the building overlooking the main areaways between the shop buildings. The office for the superintendent of shops is so located as to command a view of almost the entire plant. Adjacent to his private office are located the conference room and the general office for the clerks of this department. Conveniently located is the well lighted drafting room, which connects with the blueprint room where there is apparatus for making blueprints almost instantly at any time of the day or night. A large room, connecting with the drafting room by large sliding doors, is provided for the shop apprentice classes. The partition between the rooms is entirely of glass and doors, so that the two rooms can practically be thrown together for night classes. Commodious toilet rooms are provided on this floor. All the offices are finished in natural southern pine and have floors of white maple.

The store room on the second floor is served with a hydraulic plunger elevator of 3,000 lbs. capacity, having a large platform so as to handle bulky material. There are also two large outside doors on the second floor opening out upon concrete bracket platforms large enough to receive material from the yard locomotive crane, operating on track adjacent to the building.

The store department is equipped throughout with steel shelving and racks of a new "universal" design, made by the Lyon Metallic Manufacturing Co., of Aurora, Ill. All racks are designed to suit the requirements of the different classes of materials carried and the stock is departmentized in accordance with the "Frisco" standard classification, as developed by Mr. J. R. Mulroy, general storekeeper.

The building is of reinforced concrete construction throughout. There is no wood used except in windows, and a small amount of trim. All racks and shelving being of steel, and fire hose outlets being provided at frequent intervals, practically all danger of damage by fire is eliminated.

The oil carried in stock is stored in reinforced concrete tanks outside of the building and under the adjoining platform. It is drawn from the tanks by a battery of pumps, located in a room in the east end of the building, which is sealed off from the rest of the building by a blind wall, only one outside entrance being provided. This opening is covered by a steel shutter, the same as is used on all other outside doors of the store building. Storage space is provided in the fire-proof, oil drawing room for waste and other inflammable supplies.

The Transfer Table and Traveling Yard Crane.

The electric transfer table serves directly the machine and erecting shop; the boiler and tank shop; the coach repair shop, and the coach paint shop; also the future wheel shop and extensions for all departments. The table is 80 feet long, has a live load capacity of 180 tons and runs at a speed of 300 feet per minute. The pit in which it travels is 1338 feet long, or a little over a quarter of a mile. The table is operated by two electric motors, in the same manner as a double truck electric

car. Current is supplied to the motors by means of a third rail system, the current-conducting rails being located on each side of the pit under a protecting ledge of the concrete retaining wall.

In order that the presence of the pit between the buildings may not interfere withe the cross traffic between the various departments, concrete walkways five feet wide are located 100 feet apart along the pit. The bottom of the pit is 18 inches below the yard grade, and in order that the trucks may cross the pit easily on these walkways, an incline, or romp, 20 feet long, is provided on each side of the pit, thus eliminating any retarding of material handling due to the presence of the pit.

The electrical third rail system for conducting current to the motors on the table was developed to meet the requirements of these necessary walkways. Owing to the incline into the pit on each side cutting through the wall, it was, of course, impossible to string trolley wires continuously from end to end, and to get around this difficulty the third rail conductors were installed in sections between the walkways and connected together at these points by means of copper cables inserted in tile ducts, laid in the concrete wall under the walkways. This, of course, leaves gaps about five feet wide every 100 feet in the conductor rail, but current is supplied to the table continuously by having a pair of contacts, or "shoes," on each end of the table, which span these gaps, the forward shoe always making contact on the next section before the rear shoe leaves the last section of conductor rail.

This arrangement of transfer table and pit was the first of its kind ever installed, and appreciation of its many advantages is evidenced by the several similar tables which have been installed since the details of this one were first published.

A signal system is provided for the protection of workmen crossing the pit on the walkways during hours the transfer table is in operation.

The pit rails, upon which the transfer table runs, are of 85-lb. steel, resting on steel tie plates and creosoted wood ties, 16 feet long, which are embedded at intervals of 18 inches in the concrete supporting walls. This provides heavy and permanent construction, suitable for the most exacting service.

Owing to the length of the concrete walls, expansion joints are provided every forty feet, and to prevent any possible uneven settlement of adjacent sections at these points, a heavy reinforced concrete mat has been placed immediately under the joint. These were placed in advance of the walls and finished on top, so that walls do not bend with the mats and are thus free to move.

The east end of the transfer table pit extends under the yard crane runway, which is located at right angles to it, a distance of 25 feet, so that material can be readily placed upon the transfer table from the electric yard crane. The transfer table and yard crane runway thus become two common carriers of primary importance in the handling of material for all departments.

The yard crane runway is of structural steel; extends north and south across the shop site a distance of 800 feet, with provision for ultimate extension to the property lines. The crane rails are located 23 feet above the yard grade, and the span of the crane is 75 feet. This provides a large material yard where heavy material of all kinds can be stored and efficiently handled.

The normal capacity of the crane is 10 tons, and it will safely carry a load of 12½ tons. It has a traveling speed of 450 feet per minute and a hoisting speed of 60 feet per minute under light load conditions. The speed is somewhat less under heavy loads.

The store house platform, which is located immediately opposite the end of the transfer table pit, extending under the yard crane runway a distance of 25 feet, allows of material being readily handled from the store department via the yard crane to any department north or south, and, by placing on the transfer table, to departments west.

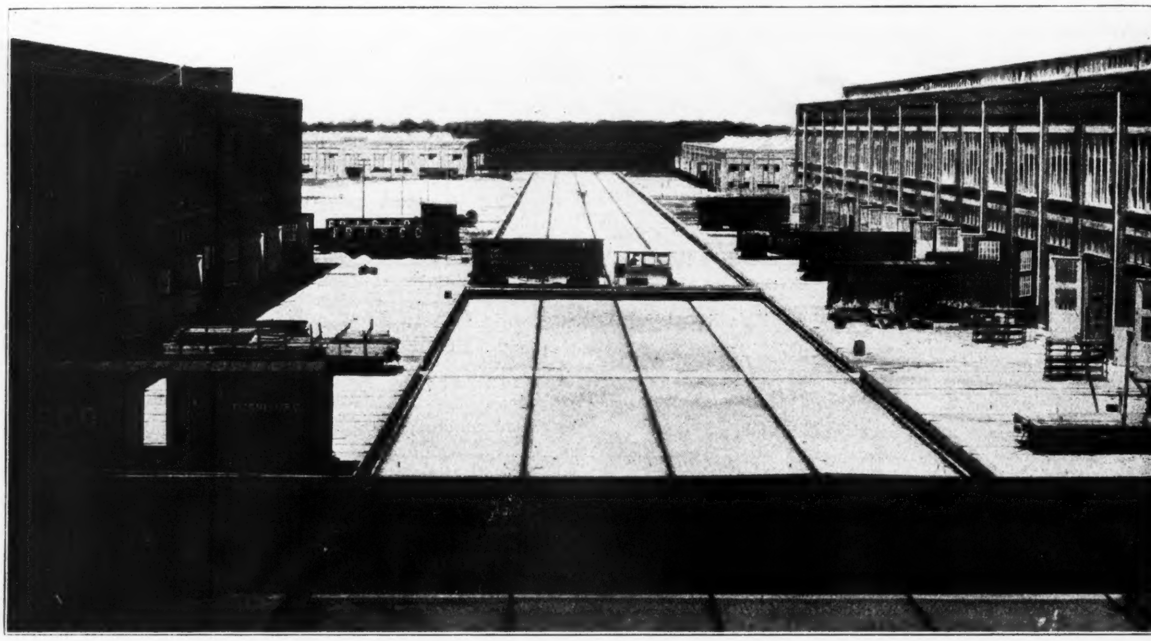
The industrial track system, which is of standard gauge, with few minor exceptions, is so inter-connected by means of turntables that free movement of materials is possible to and from all departments independent of the mechanical material handling devices above outlined. The system thus serves as an additional means of material handling, as well as for emergencies. All industrial turntables are of very heavy design, mounted on roller bearings, the tables being set on concrete foundations, thus insuring permanent alignment with tracks.

The Blacksmith Shop.

The building is 102 feet wide by 245 feet long, and has a clear height under the roof trusses of 24 feet. The trusses span the entire width of the building, so that there is not a column in the building. The floor space is 24,400 square feet, and the total content of the building is 846,00 cubic feet.

Just north of the building are located the storage compartments, 30 by 150 feet, for iron, heavy forming tools, blacksmith coal, coke and charcoal. Materials into storage can be handled directly from cars on convenient tracks by hand or by

Boiler and Tank Shop, Springfield Shops.



Transfer Table and Pit, Springfield Shops.

the traveling crane. Hatches, mounted on wheels, are provided on the roof of the bins so that coal, coke and charcoal can be unloaded by means of a clam shell bucket. Materials enter the blacksmith shop from the north via the industrial track system, and are worked through the various stages to completion, leaving the building at the west end en route to the locomotive shop, coach shop, or to the storehouse, immediately adjacent on the south.

The equipment consists of well selected and arranged modern tools, such as forges, furnaces, steam and power hammers, forging machines, revolving jib cranes for handling heavy materials from furnaces, and tools, large punches and shears, a very complete outfit of bolt and nut machinery, spring department, open fires and cranes for locomotive frame work, etc. All machinery is operated by electric motors, except steam hammers. The building is piped for water, steam, compressed air, fuel oil supply, air blast for forges and furnaces and for heating. The blast system is supplied by two large Sturtevant 10-ounce pressure blowers, driven by electric motors. These blowers are connected so they may be used singly or together. The blast system is supplied throughout with automatic dampers to prevent back firing.

All forges and fires have hoods over them, with stacks carried out through the roof, so as to minimize all smoke and gases. The building is lighted throughout by electric mercury vapor lamps. The foreman has a neat office centrally located where he has an unobstructed view over the entire shop. The floor throughout is of screened cinders, well compacted, which makes it almost like an asphalt pavement.

Locomotive Machine and Erecting Shop.

This building, which is the principal one of the group, is 173 feet wide by 566 feet long, and has a total floor space of 123,000 square feet, or nearly three acres. It is divided into three bays, the erecting bay, 65 feet wide and 35 feet under the roof trusses, and the light machinery, or balcony, bay, 40 feet wide, 20 feet from the ground floor to balcony, and 15 feet from this floor to the under side of roof trusses. All of these bays extend the full length of the building, 566 feet.

The erecting bay is provided with 25 concrete engine pits, located on 22-foot centers, each pit being 45 feet long. The pits are of massive construction, capped with heavy white oak timbers, upon which the engines are blocked when shopped. Over these pits, and carried by the heavy steel framework of the building, is a crane runway and a 100-ton (maximum capacity, 125 tons), double trolley, electric traveling crane for hoisting locomotives. There is also a 10-ton auxiliary hoist provided on this crane, and a separate 15-ton, high speed, electric crane for light work and general construction purposes. The span of these cranes is 61 feet, 3 inches. The large crane travels at 250 feet per minute and hoists at 20 feet per minute, while the 15-ton crane travels at 400 feet and hoists at 60 feet per minute.

At the east end of the building a half panel is provided in the structure, which serves to allow the 15-ton crane to run beyond the last engine pit, so that the lifting crane can be located over it. In this half panel is also located the facilities for the storing of cabs.

A series of double-decked steel racks is provided with capacity for nine cabs, any of which can be reached directly with the 15-ton crane for movement to and from any of the pits.

The locomotive carpenter shop, in which all woodwork for cabs will be done, is located immediately across the transfer table from this end of the erecting shop, so that it is very convenient to the storage racks.

Between the pits throughout the length of the erecting bay are then rolled back on the pit track, which extends a distance from locomotives undergoing repairs. There is provided in each building column a steel compartment for the storage of heavy tools used in the erecting bay, which can be locked, tools being charged out to the several gangs. At frequent intervals electric tool grinders are located for handy use of the workmen on the erecting floor.

When locomotives are placed in the erecting shop they are set with front, or pilot, toward the outside wall and transfer table. The boiler flues, which are taken from the front end, are loaded on push cars and taken across the transfer table and into the boiler shop. After being repaired they are returned by the same route. After the shoes and wedges have been loosened up, the locomotive is picked up by the large electric crane and hoisted to clear the wheel equipment. The wheels are then rolled back on the pit track, which extends a distance of 25 feet into the central or heavy machine bay, where they are stored until removed by a 10-ton electric crane, and over this to the wheel department for repairs. Massive machine tools, each driven by individual electric motors, some tools having two or three motors, are located in this bay for work

on engine cylinders, frames, wheels, tires, driving boxes and other heavy parts. All of the tools are served by the electric cranes so as to facilitate the work as much as possible.

A feature of this section of the shop is the large concrete lye vat and washing pit. An entire engine truck can be placed by the overhead crane directly into the lye vat to pickle and remove the accumulated grease and dirt, when it is removed to the adjacent washing pit and flushed off with hose and clear water. In order to prevent any possible fumes from the lye vat from contaminating the air of the shop, a sectional steel cover is provided, handled by the crane, together with an electric driven exhaust, which sucks all the fumes out through a duct leading through the roof. A concrete floor surrounds the vat, which drains into the sewer, thus insuring the utmost cleanliness.

The light machinery bay, over which the balcony is located, contains many tools for the lighter classes of locomotive parts, such as pistons, valves, valve motion, links, rods, etc. These tools are in most instances driven by bolts from a lineshaft, which is divided into short sections, or groups, each group driven by an electric motor. The shaft is so aligned, however, and provided with flanged couplings, that in case of a motor becoming disabled, the inserting of a few bolts will connect two or more sections together for such emergencies. The tool room is located near the center of the building in this bay. This department is separated from the rest of the shop by woven steel wire partitions and contains fine tool making machinery, as well as a complete equipment of steel racks and shelving for the storing of tools. Along the outer wall, where the best north light is available, almost a continuous line of work benches is located. These benches are covered with steel tops and provided with vises and many lock drawers for keeping the tools of the workmen who are on this class of work.

On the balcony floor, which is of reinforced concrete, capped with hard pine, so as to make it easy on the feet of the workmen, is located the tin and copper shops, the pipe shop, the air brake, injector, electric headlight, and boiled lagging departments, as well as other classes of light work. A balcony floor ledge, extending out under the crane of the heavy machine bay a distance of seven feet, makes it possible to pick up an article anywhere on the floor of the heavy machine bay and place it on the balcony at any point in the shop. In the balcony are also located the large blast fans for the heating system. There is considerable machinery located in the balcony in the brass working and pipe departments, all operated by electric drives, either in groups or with separate motors. Work benches extend the full length of the building along the north wall.

The building is piped throughout for water, steam, compressed air and heating. It is lighted artificially by means of electric mercury vapor lamps, while the natural lighting is unusual for a building of its size. Windows are largely pivoted or hung so as to provide the best of ventilation. Mechanical assistance in the ventilation is also provided in the three large blast fans which change the air once every thirty minutes. Air chambers and flues are arranged so as to receive fresh air from the outside, as well as the recirculated air of the room, mix in the proper proportion and then distribute over the entire building through underground concrete ducts. Both suction and discharge ducts are provided so as to control the movement of the air to a nicety and thus prevent local drafts and dead air pockets, which are objectionable to the workmen.

All of the electric mains supplying motors and lights are located underground in tile and concrete ducts, easy of access for the present and the future, and greatly reducing the amount of exposed wiring to collect dust.

Locomotive Boiler and Tank Shop.

This shop, which is tributary to the erecting shop, is located in a building immediately across the transfer table from it. Its dimensions are 118 feet by 347 feet, with a floor space of 39,000 square feet, and a total content of 1,742,000 cubic feet. At the east end of the building, 60 feet, extending the full width, is partitioned off by a heavy fire wall to provide space for the locomotive carpenter shop. In this department is done all wood work upon engine pilots, bumper beams, cabs and tank frames. Electric motor-driven groups of woodworking machinery are located on one side of the shops, and the other is devoted to floor work and assembling.

The boiler and tank shop proper, consisting of two bays 280 feet long, is served over the entire area by electric traveling cranes. The main bay, 65 feet wide and 38 feet under the roof trusses, contains 14 tracks on 20-foot centers for assembling

Interior View of Blacksmith Shop, Springfield Shops.

Pit Bay of Erecting Shop, Springfield Shops.

work on boilers and tanks. Over these tracks is located a double trolley crane of 30 tons capacity. At the east end of the bay next to the fire wall is located the riveting tower, designed for installation of future hydraulic riveting stake of large size, to do the heaviest class of work.

The machine bay, immediately adjacent to the assembly bay, contains many powerful tools for forming and finishing of boilers and tanks, such as annealing furnaces (one being large enough to heat heavy plates 12 feet square), bending rolls, rotary bevel shears, splitting shears, plate punches, flange punches, riveters, radial drills, etc. Nearly all are driven by individual electric motors; the remainder are arranged in convenient groups.

In the center of the shop, and on the machine-bay side, is located the large blast fan of the heating system, purposing the same function as those described under the "machine and erecting shop."

The building is piped for water; high pressure steam testing lines; an abundance of compressed air; fuel oil supply for furnaces; air blast system for forges and furnaces, and for heating. It is lighted artificially by electric mercury vapor lamps, and numerous receptacles are also provided for portable incandescent lamps for use inside of the boilers, etc.

Coach Repair Shop.

This building contains 22 stalls for coach repairs: cabinet shop and upholstery department. It is 209 feet wide by 304 feet long, with 20 feet of clear height under the roof trusses, and a total floor space of 52,000 square feet. The roof is of sawtooth construction, all glass facing the north, so as to secure absolutely uniform lighting over the entire building.

The cabinet shop and upholstery room are located in the east end of the building. The cabinet shop is equipped with a full complement of woodworking tools, and in addition, numerous cabinet makers' benches of spacious dimensions. A long glue drying room is provided with special steam coils arranged to secure any desired temperature. The upholstery department is adjacent to the cabinet shop, and is provided with upholsterers' benches; separate rooms for cleaning and renovating work, and a balcony for sewing machines and finishing work. The general foreman's office is located at the east end of the building connecting with both of the above mentioned departments.

The coach repair shop proper is arranged for two coaches on each track with a common bay between them in the center of the building. Over this bay is located a 10-ton electric traveling crane operated from pendant control cords at the floor. Under this crane runway all truck work will be done, the trucks being pushed forward under the crane after a coach is raised on blocks.

A complete system of permanent steel scaffolds for all coach stalls is provided. All scaffolds are adjustable for any height and distance from the car desired, and when the scaffolds are not in use, they may be quickly pushed up out of the way, clearing the floor seven feet, all vertical supports being counterweighted.

The building is piped for water, compressed air and steam, where it is needed, as well as for heating. It is lighted by incandescent lamps, with the exception of the truck bay and cabinet shop, where machinery is located, these being lighted by mercury vapor lamps. All machinery is driven by electric motors, those in the cabinet shop being arranged in groups, and all others are provided with separate motors.

Coach Paint Shop.

After the coaches have been put into shape for final painting, varnishing and refitting, they are transferred by the transfer table immediately across from the coach repair shop to the coach paint shop. This building is 183 feet by 184 feet, with a floor space of 32,600 square feet. It contains 16 stalls, each stall being provided with a concrete pit, 81 feet long and 8 inches deep. The heating pipes are arranged in these pits as they will assist in the drying of the varnish. The building also contains separate corners for paint mixing, brass cleaning,

plating and polishing. These rooms are cut off from the main portion of the building by fire walls.

At the east end of the building a large space is also set aside for sash work, where very complete facilities are provided in this class of work.

The paints and varnishes used in this building are stored in underground tanks, from which pipe lines lead to a battery of measuring pumps, located in the mixing room, where supplies are delivered to the painters.

The same system of counterweighted adjustable steel scaffolds is provided in this building as in the coach repair shop.

The natural lighting of this building is a notable feature due to its uniformity of distribution, saw-tooth construction being used over the entire area. The floor throughout is of finished concrete and well drained to bell traps located at intervals both in and between the pits.

The artificial lighting consists of incandescent electric light located between the tracks and provided with long cords for interior work on coaches. The brass polishing machinery is driven by electric motors, and the building is piped throughout for compressed air for paint burners, frequent hose valves for water service, and steam heating.

Power House.

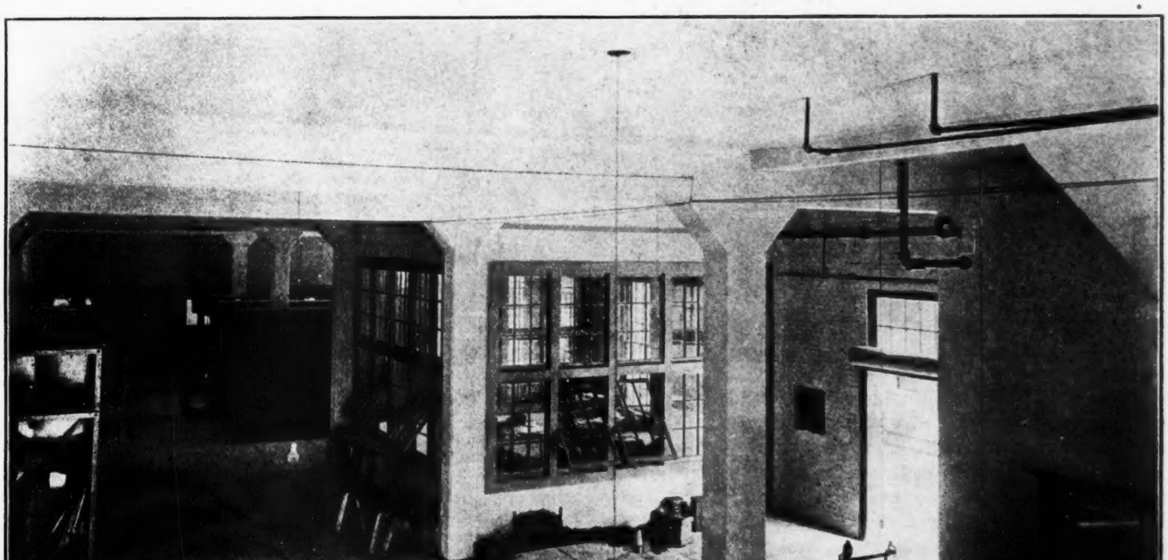
The power house contains the complete central power station for the new shops and also furnishes power to the old north shops. The building at present contains 2,000 horse power in boilers, but it is designed to house 3,200 horse power and provision is made for further development when it becomes necessary. The building is 118 feet by 145 feet, with a total floor area of 30,000 square feet; it is fireproof, being constructed throughout of non-inflammable materials, with the exception of the window frames and doors.

It is subdivided into three rooms by brick fire walls, the turbine and boiler rooms being on the same level and each being provided with a 10-foot basement well lighted and ventilated. The chimney is of reinforced concrete, 10 feet in diameter by 205 feet high. It is provided with high-class lightning rods and conductors. The smoke flues connecting the boilers with the chimney are of concrete and located in the basement of the building.

The five boilers are each 400 horse power of Babcock & Wilcox water tube type. Space is provided for additional 400 horse power boiler. The boilers are provided with superheaters of the same make. The boilers carry a steam pressure of 150 pounds, and the superheaters raise the temperature of the steam an additional 100 degrees. Each boiler is provided with a Green traveling link grate. These grates, or stokers, are operated by lineshaft in the basement, which is driven in turn by duplicate auxiliary engines. A system of narrow gauge tracks and turntables, an electric elevator, and manually-operated bottom dump coal and ash cars, have been installed. This equipment is so arranged that the coal and ashes can be handled by one man at a low expense. There is little about the equipment to deteriorate, as all storage pockets are of reinforced concrete. All coal and ashes are handled by gravity, with the exception of the movement over the electric elevator, which raises both coal and ash cars to the overhead bunkers. The storage capacity for coal in the main bunkers is 350 tons. Coal may be unloaded into these bunkers directly from bottom or side dump standard coal cars, or may be unloaded from gondola cars either directly by hand, or by means of clam shell bucket and locomotive crane on adjacent track. The storage capacity in the overhead bunkers is 320 tons, from which point coal flows by gravity directly into the hoppers on the stokers.

These bunkers are of a new and novel design patented by the Brown Hoisting Machinery Company of Cleveland, Ohio. They are of the suspension type, the material, which is of steel and concrete, hanging from the supports in the shape of a parabola; thus placing the materials so as to throw practically all the steel in tension, and in this way take advantage of the maximum strength of the material. The shape of the bunker is particularly advantageous from the standpoint of discharging all the material in the bunker through the outlets by gravity; that is, there are no pockets from which the coal cannot easily flow.

There is also provided beneath the main bunkers, emergency



Interior View of Storehouse, Springfield Shops.

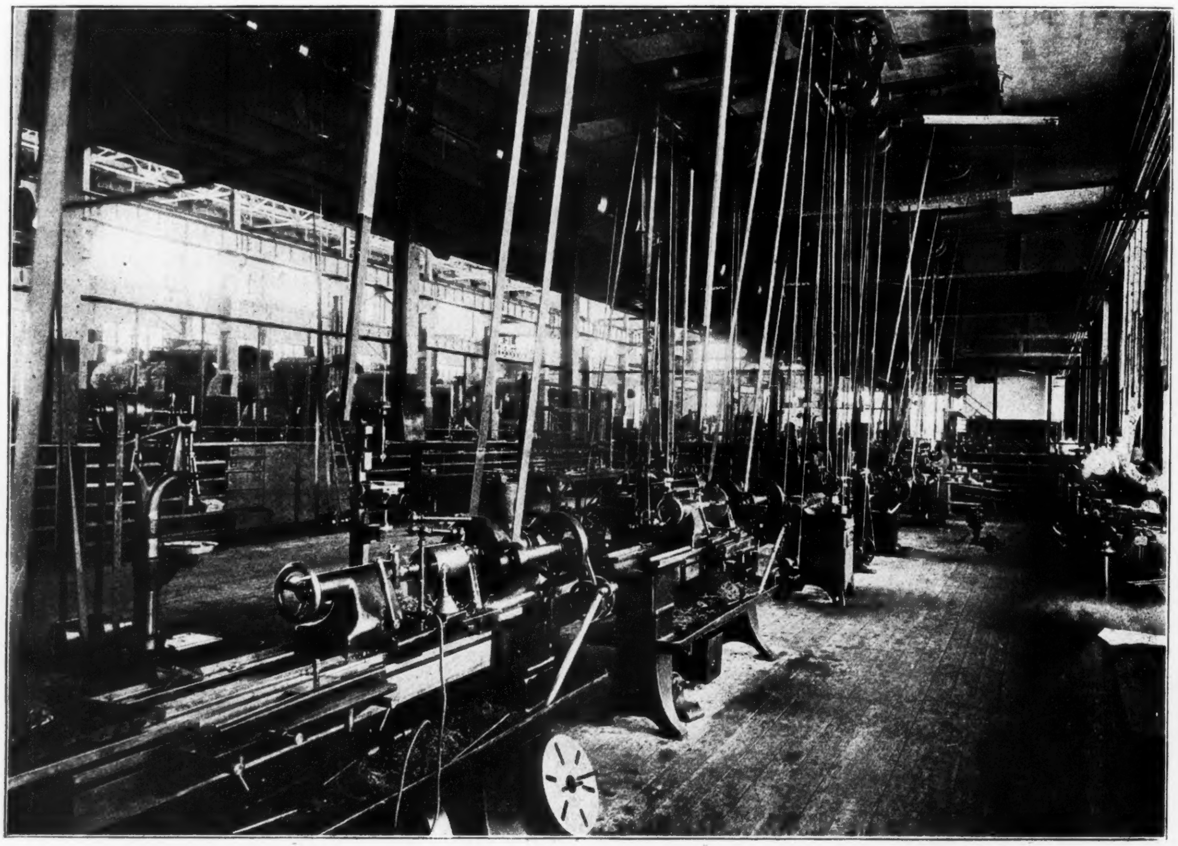
coal pockets, in which can be stored an additional 400 tons of coal, which can be handled almost as economically to the boilers as in the regular storage compartments. This coal, however, must be unloaded from gondola cars by hand through convenient steel coal doors. It is not intended to use the lower pockets for regular coal storage, and the space is therefore available for general storage of miscellaneous materials, such as are used about the plant. The overhead ash bunker has a storage capacity of a carload of ashes. The ashes are delivered directly to this bunker by the electric elevator, from which they are discharged by gravity directly into a car on the coal storage track below. The small coal cars which are used for transporting coal from the lower storage to the overhead storage each has a capacity of one ton of coal.

A pump and piping room, in which particular attention has been paid to the ventilation, is provided between the boiler room and the turbine room of the plant. This room contains a 2,000 horse power Webster open type feed water heater; two American Steam Pump Company's boiler feed pumps of 2,000 boiler horse power each; two large vacuum pumps, which return the water condensation from the general heating system to the feed water heater, and thus return the condenser water to service. There are two engine-driven centrifugal circulating pumps of 2,440 gallons capacity per minute, which furnish cooling water for the condensing equipment, and two compound fire and service pumps, each of 1,000 gallons per minute capacity, which provide general water service at a pressure of 65 lbs. per square inch, and, in case of fire, 100 lbs. per square inch. This room contains practically all steam, exhaust and water piping for the entire plant. It is arranged for easy access to all valves and other parts by means of steel runways.

The turbine room contains two 500 kilowatt Westinghouse turbo-generators; one 300 kilowatt rotary converter; one 30 kilowatt Westinghouse engine-driven exciter; one 13-panel switchboard about 40 feet long; three 150 kilowatt transformers for transmission line to North Shops; one 2,000 cu. ft. Laidlaw-Dunn-Gordon compound, two-staged air compressor. The room is also designed to provide for another 2,000 cu. ft. air compressor and two more turbo-generators, one 500 and one 1,000 k. w.

Each of the turbo-generators and the air compressor is provided with a barometric condenser, which gies a vacuum of 28 inches. All pipe and electrical connections to the apparatus are below the floor, where an ample basement is provided. In addition to other auxiliary apparatus, located in the basement, is the oiling system for machinery roof. Fresh air for the air compressor and for the ventilation of the turbo-generators is provided in the shape of suitable ducts in the basement, which connect with a protected opening to the exterior of the building.

The turbo-generators, which are of the Westinghouse-Parsons type, are of interest, due to certain features of design, which are along very modern lines. Each unit has a capacity of 500 kilowatts, delivering three-phase, sixty cycle current at 480 volts. Generators are of the revolving field type, speed being 3,600 revolutions per minute. In this type of apparatus the energy is derived by allowing steam to expand from high pressure and temperature to low pressure and temperature through a series of alternately moving and stationary blades, or vanes, termed respectively the rotor and stator. The rotor vanes are carried on a series of drums of different diameters mounted on steel shaft. Stator, or stationary blades, are placed inside the casing, fitting closely around the drum; the steam, being admitted through a suitable governor at the small end of the casing, increases in volume progressively through the stages to the large drum, where it is exhausted into the condenser. The successive impact of the steam on moving and stationary blades imparts a rotary motion to the shaft, which extends



Tool Room, Springfield Shops.

through the casing to drive the generator. The relation between moving and stationary blades is such as to produce an effect similar to a simple steam nozzle and a wheel carrying a series of vanes.

Water System.

Water for the plant is obtained from two sources and provision is made for a third. First, three 8¼-inch deep wells, 900 feet deep, delivering 150 gallons per minute, by means of motor-driven "Downie," double-acting, deep well pumps. These pumps discharge into a gravity pipe line leading to a cistern in the pump room of the power house, called the "well water cistern." The second source of water supply is a pond covering 15 acres, with a capacity of 20,000,000 gallons. This water is impounded in an area arranged for the purpose on the shop property.

The rainfall from over 200 acres of ground on the site, including 7 acres of roof area, is drained into the pond by means of a storm sewer system. An 18-inch tile gravity pipe line conducts water from the pond to a cistern in the power house, adjacent to the well water cistern. A pipe connection is provided between the well water cistern and the pond water cistern, which can be regulated to suit requirements.

The water used for general service and for fire purposes is pumped from the pond water cistern by means of two compound steam pumps of 1,000 gallons per minute capacity each into a 100,000 gallon elevated steel water tank on a steel tower. The top of the tank is 160 feet above the ground. Water is distributed from this tank by means of a network of cast iron underground mains, covering the entire shop site, and serving all departments. The gravity pressure on water system with tank about full is 65 lbs. per square inch.

There is a separate underground distributing system for drinking and lavatory purposes, serving all departments, water for which is taken directly from the cold well water cistern. Condensing water for the steam turbines and air compressor is taken from the pond water cistern by means of two centrifugal circulating pumps of 2,440 gallons per minute capacity each. Water discharged from the hot wells of the condensers flows by gravity into the main trunk line storm sewer, thence back into the pond, which, due to its large surface exposure, cools by evaporation ready for recirculation.

It has been found by experience in this district that the normal evaporation from a pond of this character just about equals the rainfall, but while the exposed surface of the pond is about 15 acres, the rainfall from over 200 acres is saved. It is estimated that the rain water thus provided will furnish a large part of the requirements of the plant for steam and general purposes, thus reducing the pumping from the deep wells to a minimum. The pumps in the power house are so cross-connected and provided with valves that, in case of emergency, service can be interchanged on circulating, general service and drinking water pumps. In case of fire the two 1,000-gallon per minute pumps can take water direct from the 20,000,000-gallon pond, or from the 100,000-gallon elevated tank by a system of valved cross connections, the pressure being raised to 100 lbs.

Tool Bay of Boiler and Tank Shops, Springfield Shops.

There are 25 outside fire hydrants located on the shop site at suitable distances from the buildings, each hydrant being provided with two 2½-inch hose connections. Inside of the buildings is provided a total of 97 2½-inch hose valves, 52 of which are provided with hose rack and 50 feet of Underwriters' fire hose and nozzle.

Cold water direct from the deep wells is piped underground throughout the various departments, and numerous sanitary drinking fountains are located in all the buildings, so that the workmen anywhere have only to go a few steps for water.

Heating System.

All the buildings are heated by means of the exhaust steam vacuum system, utilizing exhaust steam from the power plant units (in the winter time running non-condensing). The exhaust steam is conducted from the connection at the power plant by means of a large pipe line located in a concrete tunnel connecting with the various buildings. This tunnel is 7 feet wide by 5 feet high. In addition to the heating pipes, lines for

Interior of Coach Paint Shop, Springfield Shops.

high pressure steam, compressed air, and condensed water returns are placed in this tunnel. All of the pipe lines are arranged for easy access and inspection.

The machine and erecting shop and the boiler and tank shop are each heated by means of a combined hot blast and direct radiation system. Two-thirds of the heating capacity in these buildings is in the hot blast, or indirect section, the remaining one-third consisting of direct radiation, which takes care of wall exposure and openings. Either or both of these systems can be operated in various degrees to suit requirements of the weather. The blast fans in these buildings make a complete air change every 30 minutes, which materially benefits the ventilation of the buildings.

The coach repair shop, coach paint shop, blacksmith shop and storehouse are heated by means of direct radiation only. This radiation is so disposed as to take care of the exposures in the most economical way, at the same time placing radiation so that it will not in any way reduce the available working space within the buildings. All condensation from the radiation in the various buildings is returned through a pipe line to the power house, in which is located vacuum pumps in duplicate, which discharge the hot water into the feed water heater, from which point, after further heating, it is delivered to the boilers. The saving of this hot water is an item of considerable importance.

The vacuum system on the radiation is what is known as the "Van Auken" type, by means of which the steam pressure on the heating mains is kept down to atmospheric pressure at the exhaust connections from the steam turbines and air compressor, and under many conditions a considerable vacuum is obtained at this point, thus relieving the power plant units of any back pressure. The full capacity is available both summer and winter.

High Pressure Steam System.

Dry steam at 100 lbs. pressure is furnished from the power house through a regulating valve, and is piped to all buildings requiring it: for the steam hammers in the blacksmith shop, the testing lines in the locomotive erecting and boiler shops, the glue room in the cabinet shop, the brass cleaning rooms in the coach paint shop, and for the engines driving blast fans for heating and ventilating system.

During the heating system the latter engines exhaust into the heating system mains, as well as all of the steam hammers, so that all waste steam is saved and utilized as far as possible. The distributing pipe lines are carried underground in tunnels and are all well insulated from heat losses.

Compressed Air System.

Compressed air at 100 lbs. pressure is supplied by the 2,000 cubic foot compound air compressor located in the power house. Two large steel reservoirs are located just outside the power house, which receive the air and cool it. From there it is distributed by means of a system of underground pipe lines to all buildings and departments. Numerous outlets are located at frequent intervals, provided with hose connections, so that air for the operation of drills, reamers, riveters, clippers, caulkers, expanders, and a great many other purposes is always at hand.

Fuel Oil System.

Fuel oil is received in tank cars on a track just east of the storehouse. Hose connections are made between the tank cars and inlet pipes leading to underground concrete storage tanks, which have a total capacity of about 40,000 gallons, or five carloads. From these reservoirs the oil flows by gravity, as required, to an auxiliary underground tank, from which it is pumped by electric motor-driven centrifugal pumps, up into an overhead tank located in the blacksmith shop, from whence the oil is distributed by gravity pipe lines to all furnaces in the blacksmith shop and boiler shop.

The electric pumps are automatically controlled by an electric device, which start either or both pumps when the oil falls below a certain level in the overhead tank, and stops them when the tank is full. The supply line is metered to measure the oil used in the shops.

Lighting and Power Systems.

Three-phase alternating current of 60 cycles at 440 volts is generated by two 500-kilowatt turbo-generators in the power house. These machines deliver the current to the controlling

and distributing switchboard, from which a portion of the power is delivered to a 300-kilowatt rotary converter, which in turn delivers direct current at 220 volts. A direct current switchboard is provided for this section of the power supply.

Alternating current is used for all lighting and for all constant speed motors. Direct current is supplied to all electric cranes, transfer table, and variable speed motors on machine tool drivers.

The 150-kilowatt transformers, located in the power house, receive alternating current at 440 volts and step up to 6,600 volts for the transmission line to the old North Shops, where the voltage is again stepped down to 440 volts for the power supply to the plant. Controlling apparatus is provided so that the new plant and the old one may be operated together, or separately, and power can be supplied to the capacity of the line (450 kilowatts) to either of the shops from either of the power houses.

The feeders from the new power house for the new shops leave the building in underground conduits, from which some of them lead to overhead mains carried on the back of the yard crane runway girders to the various buildings. A portion of the feeders lead underground direct to the panels at centers of distribution. All distributing panels are enclosed in locked steel cabinets. The lighting in the various buildings is described elsewhere, but in general it consists of Cooper-Hewitt mercury lamps. Numerous plug receptacles of very heavy and serviceable design are provided on columns and walls for portable lights. All lighting circuits carry a potential of 220 volts, a balancing induction coil being located at each distributing center, which is connected to the 440-volt mains, thus converting into a 3-wire, 220-440 volts system. The different centers are balanced up on the phases so as to load the mains uniformly.

All A. C. (alternating current) motors are of the 440-volt, 3-phase type. These drive all groups of belt-driven tools and such individually-driven tools as can be operated by constant speed motors, such as punches, shears, grinders, presses, some drills, etc. Tools such as heavy lathes, boring mills, radial drills, shapers, millers, etc., which require a wide range of speed, are driven by direct current, 220-volt motors, with speed ranging 2 to 1, 3 to 1, or 4 to 1, as required for the service.

All alternating current motors are provided with auto-starters. All direct current motors have drum type controllers, all being protected with circuit breakers of standard types.

Telephone System.

A central telephone exchange is located in the office building, from which circuits run to the various departments, providing each foreman with telephone communication to any other department, either at the new shops or either of the old plants. Telephones are of the desk type and are as conveniently located as possible throughout. A total of 14 is provided in the local departments.

Fire Alarm System.

A "Gamewell" fire alarm system consisting of 12 stations is provided. The alarm boxes are located outside of the buildings near the doors, and boxes are so spread that one can be reached anywhere on the shop site within a radius of 200 feet. The boxes connect to the central station in the power house, where a switchboard and battery is located, as well as the alarm apparatus. This consists of a gong, whistle trip and recording device, all electrically operated. When a signal comes in the gong strikes the number; the recorder records the number, and the trip blows one blast on the whistle to attract the attention of the engineer, should he by chance not hear the gong strike.

Pennsylvania Relief Fund

With a membership of some 138,000 men out of approximately 158,000 employes, the Pennsylvania Railroad System Relief Funds paid out in the month of August the sum of $143,696.28. According to the report of August, issued today, there has been paid in benefits since the relief funds were established in 1886, a total of $26,846,644.06.

On the Lines East of Pittsburg and Erie in the month of August, payments to the amount of $106,873.03 were made to members of the relief fund. In benefits to the families of members who died, $39,782.61 were paid, while to members incapacitated for work the benefits amounted to $67,054.42. The total payments on the Lines East of Pittsburgh since the relief fund was established have amounted to $19,584,823.55.

In August, the Relief Fund of the Pennsylvania Lines West of Pittsburg paid out a total of $36,859.25, of which $13,000 were for the families of members who died, and $23,859.25 for members unable to work. The sum of $7,261,820.51 represents the total payments of the Relief Fund of the Pennsylvania Lines since it was established in 1889.

Painting Steel and Iron Structures*

Early in the season circular letters were sent to several members of the Association, some of which very kindly sent replies, all of which we present in full.

COPY OF CIRCULAR LETTER.

In order that the committee on subject No. 12 may be able to make a full and complete report to be submitted to the Convention to be held at Jacksonville, Fla., October next, they desire your co-operation, and submit the following questions, which, if you will kindly answer, and also add any information you think will be of interest in making this report, will be very much appreciated by this committee.

1. What do you consider the best paint to use for the preservation of steel and iron structures where exposed to fumes from coal and coke from locomotives?

2. What effect does salt water have on steel and iron where wholly or partly submerged all or a part of the time?

3. What has been your experience in the use of compressed air in painting and cleaning iron and steel structures?

EXTRACTS FROM LETTERS RECEIVED IN REPLY.

J. P. Snow, Chief Engineer, Boston & Maine R. R.:

1. I find that paints based on vegetable oils and gums are better than those based on mineral oils, for exposures to engine gases and open weather conditions. Under water, mineral oils are better than vegetable. The pigment affects the result but little, provided it is fine and free from active chemical agents in itself.

Graphite of the best brands has given us good service. The lead paints, if pure, are good. Red lead tempered with white lead, graphite or lampblack is excellent for a first coat.

Some of the ready mixed paints are good, if not superior to the above; Harrison Bros'., Edward Smith's, Tock Bros'., and Jones' paints are very good in my opinion. The first two are based on gums. A late production of Harrison Bros'. compound with a preparation of chromic acid it worthy of trial.

No one paint is best for all locations, and the best for a given place will do but little good unless the iron is perfectly free from rust and scale and perfectly dry when painted. Experiments under national auspices are now under way at Havre de Grace and at Atlantic City, but the chances are that all good paints will prove nearly equal.

2. My experience goes to show that steel does not corrode so rapidly in salt water as when exposed to engine gases or to brine drippings in the open air. I cannot explain the reason for this, but it seems to be a fact that the scale adheres under water more firmly than in air and serves in a way to protect the metal.

3. My experience with sand blast operated with compressed air shows that it is about the only way by which iron can be prepared to receive paint perfectly. If new work is followed up every year for five or six years by painters it can be saved from

*Report, in part, of Committee No. 12 of the American Bridge and Building Association.

corrosion, but if left a few years it is very difficult to stop serious rusting without the sand blast. If sand-blasted, the iron can afterwards be kept in good condition by ordinary painting if followed up closely enough. As to painting with compressed air by spraying: it is not worth while on metal bridges; the surface to be painted is too small.

R. P. Mills, Supervisor of Buildings, New York Central Lines:

1. One or more coats of pure red lead mixed with pure raw linseed oil and japan, in proportion as follows:

200 lbs. pure red lead,

80 gals. pure raw linseed oil,

1¼ gals. japan, free from benzine or turpentine mixed in the following way:

A suitable quantity of the pigment shall be permitted for twenty-four hours to absorb its full capacity of raw linseed oil; thereupon, it shall be worked or stirred to the consistency of a stiff paste. As much of this paste as may be needed for the next six hours or less shall then be thinned out with the requisite amount of oil required to give the ultimate proportions as stated in the formula. In no case shall the paint mixed ready for use be more than six hours old at the time of application. This should be followed by one coat or more of Dixon's graphite paint, or of the following formula:

220 lbs. lampblack ground in pure linseed oil.

50 lbs. asphaltum varnish made from pure high grade Egyptian or Utah asphaltum, properly combined with pure linseed oil and turpentine, free from benzine, tar, resin, boneback, etc.

15 gals. pure raw linseed oil, refined.

15 gals. pure japan, free from benzine or turpentine.

2. The effect is very injurious, and to prevent I have found a heavy coating of grease, wrapped with a two-ply tar paper, then coated with tar, to be very effective. My experience with all kinds of paint has failed to give good results, and the above mentioned I have found to be very effective, and protects the life of steel or iron indefinitely.

3. I have never had any use for compressed air for painting, although I have found it very effective for cleaning iron, steel and stone work with the sand blast.

G. Aldrich, Bridge Supervisor, New York, New Haven & Hartford R. R.:

1. The best preservative that I have ever had anything to do with is a good quality of graphite paint. It stands the gases better than anything else I have ever had occasion to use.

2. I think we have no structure of this description. I had, however, some years ago charge of an iron float bridge which was submerged in salt water several times during the day for short intervals, and the only protection it had was a good quality of graphite paint which gave good results.

3. I have never had any experience with the use of compressed air in the painting or cleaning of iron and steel structures, but it seems to me that the sand blast is the proper thing to use for cleaning and I am of the opinion that where there is a large surface to paint it could be done much cheaper with compressed air than by hand.

R. H. Reid, Supervisor of Bridges, Lake Shore & Michigan Southern Ry.:

Referring to your circular letter, asking for information in regard to painting: I hand you herewith such as I have been able to obtain from our master painters. Kindly note the reference made by Mr. Phelps to proceedings of the Association of Maintenance of Way Painters. Those desiring additional information would do well to consult the publication.

A. B. Phelps, Master Painter, L. S. & M. S. Ry.:

1. I do not believe there is any "best paint"; any of a dozen or more makes are of about equal value for the finishing coats, varying somewhat owing to location and conditions, although for all-round work there is nothing for first coat next to the iron than red lead properly applied; I would include in this all ferric structures.

2. I have never had experience with steel submerged in salt water, but salt in all other conditions which I know of (drippings from refrigerator cars, urine, etc.), causes steel to corrode badly, with an uneven surface, creating hard scales or scabs, which, when removed leave small depressions, somewhat like the bowl of a spoon, and if neglected will eat away and weaken the structure.

3. I have never had any experience with compressed air for painting, neither do I want any, from what I have observed when others were using it. From the apparent results I am fully convinced that no good job of painting can be done with it. Unless brushed after application there is a fluffy or porous condition about it that will not prevent water and air from penetrating, and the result is obvious. As to cleaning steel (for repainting) with compressed air and sand blast, the virtue of the process depends entirely upon conditions. Where air can be easily obtained the sand blast is probably all right to remove light red rust or mill scale, but out on the road where a plant must be set up to remove pits, scales or scabs caused by the action of salt brine drippings, or otherwise, the result obtained do not warrant the expense incurred. To remove these scabs hammers and chisels should be used, for the blow of a hammer will quickly remove them, as they are brittle and very hard, and for this very reason a sand blast will not cut them away any faster than it will the steel, consequently the structure is weakened somewhat in removing the scabby corrosion with the blast. All of the above conditions are fully discussed at the meetings of the Association of Maintenance of Way Master Painters, and access to the proceedings would furnish more detailed information.

J. S. Rice, Master Painter, L. S. & M. S. Ry.:

1. I construe this to refer to the iron work in roundhouses, shops, etc., and will say that I have never found a paint that will withstand the fumes for any length of time, but consider that red lead is the best I know of. When I say red lead, I mean unadulterated lead and pure linseed oil, properly applied, and the iron work put in proper condition to receive it by removing all scale, grease, dirt, etc.

2. I do not know what the effect would be of salt water on iron or steel which is submerged all of the time, but I do know that where it is submerged a part of the time the effect is very deleterious and there is no paint made to my knowledge that is proof against it.

3. I have had no experience with compressed air for cleaning, but I am of the opinion that work can be better done with it than by any other method, but unless the job is a large one I do not think it economical. On large flat surfaces, I think that painting with air would work well, but on round or flat surfaces of small area there would be too much loss of time and material.

H. Rettinghouse, Chicago & North Western Ry.:

1. My experience has been that graphite or mineral paint does not stand up any considerable length of time under the punishment accorded it when exposed to the fumes resulting from the combustion of coal and coke in locomotives, and while we are continuing the use of mineral paint it is because we have been unable to find anything which is decidedly superior to it. I am glad to see this subject brought up and thoroughly discussed, as it is one of vital importance, and a great many of us are desirous of ascertaining just what really constitutes the best paint under the conditions as set forth.

2. I have never had any experience in regard to the effect of salt water on steel or iron when wholly or partly submerged all or a part of the time. If the subject matter is intended to cover drippings of salt brine from refrigerator cars, then I could say from experience that the action is very detrimental, and I know of no paint that will withstand it.

J. Tuthill, Pere Marquette R. R.:

1. I have found a combination of red lead and graphite the best paint for the preservation of iron and steel. I have had no

direct experience with crossings that are badly exposed to fumes from coal and coke smoke from locomotives, but find the above paint gives as good service on the upper members of through bridges as any that we have ever used. Whether it would be entirely satisfactory for the under surface of bridges that have tight floors and come in close proximity to the top of locomotives stacks, I do not know.

2. I have had no experience with steel and iron in salt water, but have noticed some structures built up on iron or steel posts that were in salt water, where the iron was badly corroded, and greatly reduced, in a short time. It seems to me that some protection in the nature of concrete covering, to the extreme height to which these members are exposed, would be beneficial. It is possible that some other material could be applied that would be absolutely weather-proof, less expensive, and more sightly than concrete.

3. We have never used compressed air for painting or cleaning our iron or steel structures.

Chairman of Committee:

There are so many good paints now in use that it would be difficult and unfair to say which we think is best, for the reason that some paints used on our work seem to give results on some parts of our structures, while on other parts they last but a very short time, either going to dust or scaling. I have yet to find a paint that will last more than three years. The great trouble is that we are all prone to put off until tomorrow that which should be done today; in other words, we do not paint as often as we should.

I find that where iron or steel is left too long a very heavy coat of rust forms and it is impossible to remove it all by hand. The only way in which to clean it thoroughly is with the sand blast, after hammering off the heavy coat first, and then cleaning with the sand blast, the paint should be applied before it begins to rust. Very good results can be obtained in this way, yet it is better not to allow a heavy coat of rust to form, by painting at least once in three years. Where cleaned by hand, as we have been obliged to do at the North Station train shed, Boston, which we have just cleaned and painted, and where all the rust could not be thoroughly removed the best paints in the world will not stand; most of the paint which has been on three years is beginning to show the effect of the gases, and in order to save the structure we will be obliged to begin to paint again at once. We have used some thirty different kinds of the best paint in the market.

Mr. Snow in his report has referred to some paints which have given good results. I will add the names of a few more which are standing the test as well as those named: Aluminum Falke Graphite, mixed in oil; June Malleable Gray Copper Ore X Grade; dry lead mixed with oil by hand; these mentioned for first coat, after which Dixon's Graphite and some others are working well. In my opinion, however, I think pure lead and pure linseed oil if properly mixed will give as good and lasting results as anything that has been found.

In reply to questions 2 and 3, I agree with what Mr. Snow has said in his report.

Prizes for Track Work

Prizes amounting to $5,400 were awarded today to Pennsylvania Railroad track supervisors and their assistants who have excelled in their work during the past year. The prizes, six in number, were distributed at Harrisburg, Pa., at the close of the first day of the General Manager's annual inspection, on which the General Manager is accompanied by his entire staff of officers, including some 300 men in the operating department of the Pennsylvania Railroad.

The purpose in offering these liberal premiums is to encourage those in charge of the tracks over which the bulk of the company's passenger trains run, to keep their sections as free as possible from irregularities that cause jars and discomforts to the company's patrons.

To insure that the prizes shall be awarded upon accurate data, a committee of Maintenance of Way officers go over the line every few weeks during the year, in a car attached to one of the regular high-speed trains. Two glasses of water are placed on the sills of two rear windows and every spill of water is counted against the score of the section of track over which the train is passing. To make the record even more accurate, an instrument has been specially designed to register every vibration of the car, either vertically or horizontally. The smaller the amount of vibration, the better the track.

The Main Line Track Inspection Committee for the year 1908-1909 consisted of Joseph T. Richards, Chief Engineer of Maintenance of Way; L. R. Zollinger, Engineer of Maintenance of Way; C. T. Dabney, Superintendent of the Central Division; W. L. Cooper, Superintendent of the Bedford Division, and H. A. Jaggard, Superintendent of the Elmira Division. Their awards were as follows:

The "Klondike" premium of $1,200, of which $800 goes to the supervisor and $400 to the assistant supervisor having the best line and surface between Jersey City and Pittsburg and Philadelphia and Washington, was awarded to Supervisor G. R. Sinnickson and his assistant, M. W. Clement, both of Paoli, who have charge of the track from Woodbine avenue, West Philadelphia, to a point west of Coatesville, Pa.

The four premiums of $800 each—$600 for the supervisor and $200 for the assistant supervisor having the best line and surface on a Main Line Superintendent's Division between Jersey City and Pittsburg, Philadelphia and Washington—were awarded as follows:

Supervisor W. F. Rench and Assistant Supervisor S. L. Church, located at Tacony, Pa., who have charge of the track between Girard avenue bridge, West Philadelphia, and Tullytown, Pa.

Supervisor J. A. Burchenal and Assistant Supervisor N. B. Pitcairn, located at Mifflin, Pa., who have charge of the track between Durward and Longfellow, Pa.

Supervisor F. L. Pitcher and Assistant Supervisor W. W. Hubley, located at New Florence, Pa., who have charge of the track between New Florence and George Station, Pa.

Supervisor George Goldie, Jr., and Assistant Supervisor E. K. Large, located at Lamokin, Pa., who have charge of the track between 62d street, West Philadelphia, and Wilmington, Del.

The improvement premium of $1,000, of which $700 goes to the supervisor and $300 to the assistant supervisor showing the greatest improvement in line and surface on the main line between Jersey City and Pittsburg, and Philadelphia and Washington, was awarded to Supervisor D. T. Easby and Assistant Supervisor W. S. Johns, Jr., located at Newport, Pa., who have charge of the track between Rockville Bridge and Durward Station, Pa.

Time Schedules

Reports just compiled by the Pennsylvania Railroad show that of the 46,907 passenger trains operated by it in the month of August, 42,676, or 90.9 per cent, made schedule time.

Owing to the heavy suburban travel in the vicinity of Philadelphia and Pittsburg, the Philadelphia, Pittsburg & Maryland divisions lead in the number of trains operated. With a total of 16,043 passenger trains running over those three divisions in August, 14,953, or 93.2 per cent, of them made schedule time.

In August the Philadelphia division operated 5,680 passenger trains—a greater number than operated by any other division. The Pittsburg division was second with 5,215; the Maryland division operated 5,148 passenger trains; the Amboy division 4,789, and the New York division 3,380.

RAILWAY ENGINEERING
AND MAINTENANCE OF WAY.
BRIDGES-BUILDINGS-CONTRACTING-SIGNALING-TRACK

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Announcement

With this issue The Railway List Company becomes the publisher of Railway Engineering and Maintenance of Way. That it has been greatly improved in character and appearance and in the quality and quantity of its subject matter, the journal speaks for itself. Railway Engineering and Maintenance of Way is, and will continue to be, devoted to the engineering department and its branches and sub-divisions. It is to this department what the Railway Master Mechanic is to the mechanical department. This plan of specializing in trade journalism applies to railroads as to every other line of industry and with ever-increasing favor. It follows logically that the more interesting the subject matter of a journal is to the reader and the more directly it bears upon his work, and the problems in which he is interested, the stronger that journal will be in its field. For this reason Railway Engineering and Maintenance of Way appeals most strongly to the officials of the engineering department of railroads. Railway Engineering and Maintenance of Way will be constantly improved. It is the desire of the publisher to so conduct it that railway engineers, their assistants and aids, and industries associated with this department, will find at all times news and interesting matter in it and information that will help them. With this object and the request that readers will always feel free to ask for information and offer their suggestions on subjects pertaining to engineering problems, Railway Engineering and Maintenance of Way goes forth in its new dress with new hopes and ambitions.

The New Department

With this issue of the paper the Signaling Department is opened to our readers. It is to be conducted along the same lines as our maintenance of way department and we hope that the men in the signal department will find it of service.

We have to thank our friends who have taken an active interest in the maintenance of way department and for their acknowledgments of its service to track men. In several letters published in this issue, advice is asked on the methods of placing tie plates and the laying of steel with respect to broken or even joints. These questions have been discussed frequently at conventions, but practice varies so much and is improving that we hope the subjects will be given immediate attention by our readers.

Regarding the Signaling Department, we can not advise you of its scope at this time. We will develop it to the benefit of signal men and solicit their co-operation. Any suggestions will be appreciated and we shall endeavor to make the best use of them.

The Railway Signal Association

The annual convention of the Railway Signal Association was opened at Louisville, Ky., on October 12th, by President L. R. Clausen, division superintendent of the Chicago, Milwaukee & St. Paul. After several addresses and reports of officers were presented, proposed amendments to the constitution were submitted and adopted.

The committee reports on Mechanical Interlocking, Power Interlocking and Subjects and Definitions were ordered to letter ballot and also parts of the reports on Signaling Practice and Automatic Stops and Cab Signals. The other reports were accepted as progress reports.

The discussion on Signaling Practice was confined particularly to the report of the minority of the committee, which is printed elsewhere in RAILWAY ENGINEERING. After a long discussion, the convention adopted conclusions Nos. 1, 2 and 3, which were passed to letter ballot, and accepted that part covered by conclusions Nos. 4 and 5 as a progress report.

An amendment to the constitution, which provided for the publication of a manual of recommended practice, was passed by the convention as follows:

"Art. VI, Section 6.—The executive committee shall have printed a manual of recommended practice in which shall be published the specifications and standards of the association and such findings and conclusions, approved in accordance with Article VIII, as, in its judgment, may be considered of sufficient importance. In the manual the approval of the American Railway Association shall be indicated in connection with matters which have received such approval."

The discussion of the report on Automatic Stops and Cab Signaling indicated that further investigation was necessary before conclusions could be adopted. Messrs. J. M. Waldron of the New York subway and T. S. Stevens of the Atchison, Topeka & Santa Fe, protested strongly against the requisites as given in view of the results of practical operation.

The election of officers resulted as follows: President, H. S. Balliet, Grand Central Terminal; vice-presidents, C. E. Denney, Lake Shore & Michigan Southern, and C. C. Anthony, Pennsylvania Railroad; secretary-treasurer, C. C. Rosenberg, Bethlehem, Pa.; eastern executive members, C. J. Kelloway, Atlantic Coast Lines, and western executive member, B. H. Mann, Missouri Pacific Railway.

The first choice for the next annual meeting place was Atlantic City and the second Richmond, Va.

Turntables: Design, Length and Power for Operating*

The committee appointed to report to the Association on Subject No. 5, begs leave to submit the following:

Early in the season the following circular was sent to members of the Association:

"The undersigned committee has been appointed to report to the Association on the subject of turntables. Kindly co-operate with the committee by sending to the Chairman any information that you may have on this important subject.

"The items below are noted merely as a general guide and we would urge that the information be given in as full and complete a manner as possible.

TURNTABLES.

"1. Proper length, allowing for probable future increase in length of locomotives.

2. Plate girder tables, and cost.
3. Cast iron tables, and cost.
4. Gallows frame tables, and cost.
5. Other designs, and cost.
6. Foundation, circle wall, paving if any and pit drainage.
7. Power for operation; electricity, air and other power.

"Blue prints of standard plants will be very acceptable; if costs are given, it is requested that the amounts be divided as to material and labor as far as possible."

We are pleased to state that a very prompt response was made by most of the members and a number of these replies are submitted as forming the principal part of the report. A number of blue prints covering designs of tables, foundations, circle walls, etc., have been received, but they will not be included in the report; some of the designs which seem to embody especially modern practice will appear in the illustrations.

The days of cast iron and gallows frame turntables are nearly past. There remain plate girder tables of both deck and through types. One member reports the use of a hinged type of Pratt design, the girders being hinged at center so that ends of table take their share of the load. This table is turned by means of a 45 H. P. electric motor.

Different designs of center foundations and circle walls are illustrated and described in the attached letters.

*Report of committee of the American Railway Bridge and Building Association.

Statement and estimates of cost of complete installation of various sizes and types of tables will be found in the correspondence.

There are many points of interest regarding fastenings for both circle rails and track rails on coping walls which have been brought out in these replies from members. The committee hopes that a full discussion will be brought out on all these points. One detail which seems important, but which has been mentioned by but few members, is that of a recess in the circle wall for examination of the outside of truck wheels; one plan covering this detail is shown in our illustrations. It is a comparatively simple matter to provide such a recess and the opportunity to make examination of wheels is certainly a great convenience for making inspection and repairs.

Three kinds of power are in common use for operating turntables, namely: air, electricity and gasoline. Each has its advocates, and the different elements of loading on table, climatic conditions, frequency of turning, etc., all enter into the choice of any particular one.

The matter of cost of tables, including installation, operating devices, etc., has been reported on in many instances in great detail as a careful perusal of the letters from the members will show.

APPENDIX.

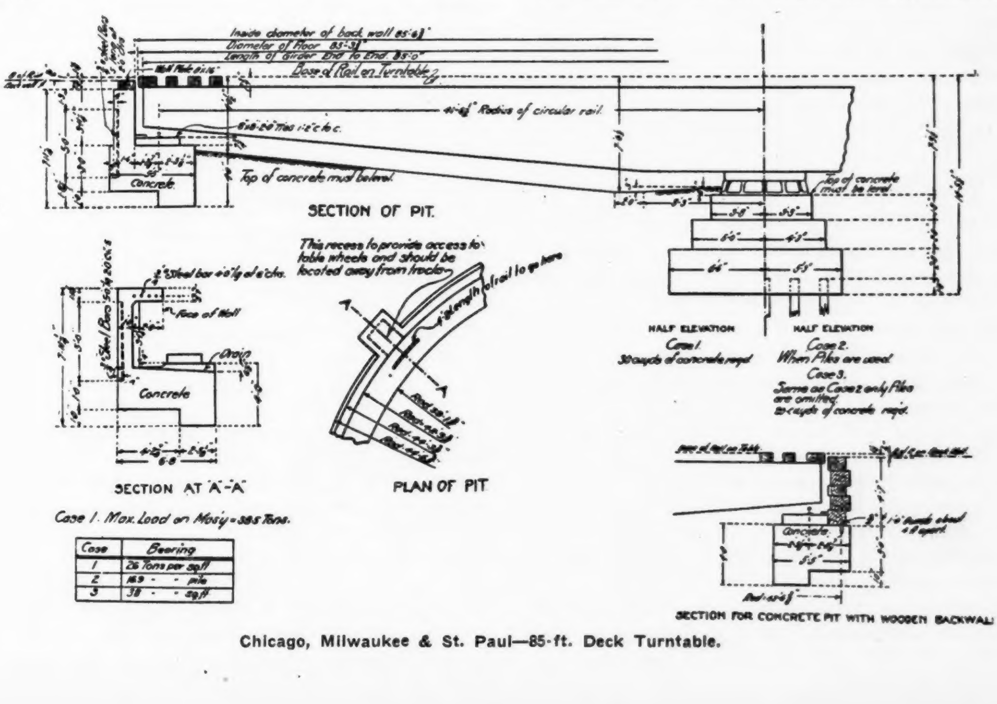
J. P. Canty, Boston & Maine R. R.:

Anticipating the probable length of a turntable required for future locomotive service, is rather an uncertain problem just at this period. However, it is the opinion of many that, on the division where I am located, the lately purchased steam locomotives have apparently reached their economical limits in both length and weight, provided the class of traffic remains similar to that which is now being handled.

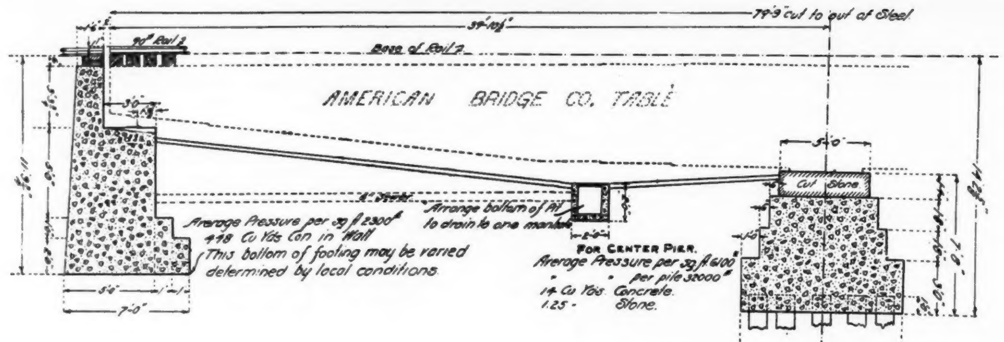
The largest engines on our division are turned easily on turntables 70 feet long. This is now our standard length, and as far as we are able to predict, will answer for future requirements.

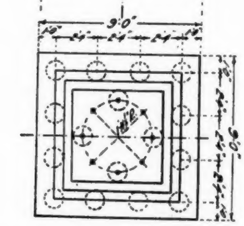
Although we have in use many turntables of different lengths and patterns, installed during the past thirty years, it seems that a report covering their design and cost would not be of any material benefit at the present time, excepting possibly from a historical standpoint, therefore, we will confine ourselves to a report on the latest pattern installed, that is the 70-foot table above mentioned.

The steel work in these tables cost approximately $2,500 on



Chicago, Milwaukee & St. Paul—85-ft. Deck Turntable.





Chicago & Northwestern—80-ft. Turntable.

board cars delivered to our road by the contracting bridge company. It is perhaps needless for me to dilate on the details of the construction of the steel work, as there is nothing unusual about the design, being made similar to those used by many other roads, that is, the customary deck plate girder pattern. However, I will mention that we specify that four cast steel end wheels shall be furnished on each end of table and the center pivot bearing shall be of the disc pattern; meaning that the table turns on a composition disc on top of the center cast steel pivot casting, instead of on the familiar roller bearing.

Our turntable center foundations have, of late, been made of concrete, being ten feet by ten feet on bottom and bearing on piles when there is doubt about the earth being sufficiently solid to carry the maximum load on this area without settling. The bottom course of concrete is generally two feet in depth. The foundation is then stepped to seven and one-half feet square by two feet thick, and a granite cap five feet square by two feet in depth is placed on top to receive the cast steel center pedestal, as shown on sketch A, herewith.

Sketch B depicts a cross-section of the concrete pit parapet and circle foundation. Notice that the circle rail and approach tracks rest on and are attached to the masonry by the use of bolts.

Sketches C and D show plans of portions of our standard pit parapets and circle rail foundations.

Sketch E illustrates in detail our pocket casting for pit parapets; these are made use of to permit the bolts, which hold approach track rails in place, to be changed if damaged.

Sketch F shows our standard rail clip, which is intended to fasten circle rail to masonry and, also, for holding rails on approach tracks to top of parapets.

Sketch G is an exaggerated drawing for making a wooden pattern for bending the circle rails to proper curve.

Sketch H portrays the arrangement of ties on our standard 70 ft. turntable.

There are 330 cu. yds. of masonry in our 70 ft. turntable pits. The whole outfit, including turning motor, costs us between $6,000 and $7,000. Figures vary for different locations, depending upon whether or not we are obliged to drive piles, provide expensive drainage, etc.

Practically all of these new outfits have been put in where older and smaller tables were installed and as the older tables were kept in service just as long as possible so as to avoid delays to engines, our work has always been made more expensive than if new tables were constructed where we would not be handicapped by keeping the old table in use.

We use gasoline power turning device.

The floors of the turntable pits are covered with a coal-tar concrete paving, about 2½ ins. thick, somewhat similar to that which is used extensively in small cities and towns in New England for sidewalk surfaces. This gives a fairly hard and elastic surface, and does not crack when soil underneath heaves with frost, and is comparatively smooth, so that it is easily kept clean and snow may be removed from pit without much trouble. The cost is about 50 cents per square yard.

H. A. Horning, Michigan Central R. R.:

For your report, if you care to use them, I will state my views in the matter pertaining particularly to service such as we have.

I prefer a deck steel-plate table, if the conditions are favorable for drainage, if not, a half-through table should be substituted. We are using tables of this kind 85 ft. in length, but 90 ft. would be better.

Great care must be taken relative to the depth of girder to prevent deflection, which is very detrimental to operation. The full load should be carried on the center, and conical rollers should be used instead of discs. The end bearings of table should have rollers instead of sliding plates. Center foundation should rest on natural rock, or piling, capped with suitable concrete block. Coping wall should be concrete on a suitable foundation, and capped with timber instead of curved rail. Pit should have cement floor and properly drained.

If possible electrical turning device should be supplied. If electricity cannot be had, gasoline is the next best method. Electric current for operating turntable should be brought in beneath the table, and the table should be well lighted.

In this territory we do not find it necessary to cover the pit.

A. H. Beard, Philadelphia & Reading Ry.:

As requested I herewith enclose two blue prints of turntables used by the P. & R. R. Ry. Co., one 65-ft. table and one standard 75-ft. table.

The cost of a plate girder standard 75-ft. table in place ready for the track rails is $7,785, as follows:

Masonry	$2,500.00
Miscellaneous	500.00
Table	4,785.00
	$7,785.00

A 65-ft. girder table has been in service at the roundhouse at Reading since 1897. This was manufactured by the Pottstown Bridge Company. Engines of all classes are turned on this table, the number turned every 24 hours (although the table is short for some engines) is 75 to 80. The cost of this table in place was $5,825.

This table at present is operated by an 8 H. P. gasoline engine, manufactured by the Williamsport Gasoline Engine Company, the cost of same in place was a fraction over $1,000, and costs for operating about $165 per month—this includes labor,

oil, gasoline and repairs; we are now arranging to install an electric motor on the same table to replace the gasoline engine.

The turntable referred to is in the roundhouse and the space will not admit a 75-ft. table.

F. E. Schall, Lehigh Valley R. R.:

1. Eighty feet long.

2. Deck plate girders 5 ft. 6¼ ins. deep at center and 2 ft. 8¼ ins. at end, spaced 6 ft. center to center, conical wheel center bearings with live ring, built for a moving load of Cooper's E. 50 engines or 4,500 lbs. per lineal foot of table. Cost about $3,200 delivered f. o. b. cars within 200 miles of bridge shop.

3. Cast iron turntables are out of date and not satisfactory for present loading.

4. Have no experience with gallows frame tables.

5. There are in use through plate girder turntables with steel floor system, but we have none on our line, and therefore cannot give cost.

6. The center foundations and circular rim walls are generally of concrete, the circular rail resting on short sawed ties. The top of rim is covered by a white oak timber coping to act as a cushion with rail tie-plated. The pit is paved with concrete about 6 in. thick, and provided with drainage. For outlying districts, and tables not used extensively, the rim wall is at times omitted, using only a segmental wall at entrance and run-off of table, using ballast under the ties of circular rail.

7. For operation we have in use electric motors, gasoline engine motors and air motors; all are giving satisfaction. When electric power is at hand, it is the most suitable power to use; when electric current must be purchased from other parties or when none is available, gasoline engine motors of from 8 to 10 H. P. will prove very satisfactory. The air motor will also prove efficient if properly installed and arranged to take proper adhesion on circular rail, obtaining a sufficient supply of air from locomotives to be turned, unless the air can be taken from a compressor near by. The air motor will not turn as many engines in a given time as either of the other two kinds, account of the time required in making couplings, but for outlying districts it is the best motor attachment available at this time. The cost of installing one of the motors ranges from $900 to $1,200.

Moses Burpee, Bangor & Aroostook R. R.:

1. I would think that 70 ft. length of turntable would be necessary for heavy locomotives for general use. Sometimes such length is necessary for cars, but usually it is not the length of wheel base which determines the length of turntable so much as their position in balancing on the table.

2. In one case 70 ft. turntable installed, including masonry of foundation and ring, as well as drainage, cost about $4,500.

3, 4 and 5. Do not use.

6. Usually find drainage of turntable necessary, and provide for it in all of our plans.

7. Do not as yet use any kind of power for operating.

A. A. Wolf, Chicago, Milwaukee & St. Paul Ry.:

1. We use 85-ft. turntable on mountain division where the heaviest power is used, and 75-ft. tables on other main line divisions.

2. We have three types of the plate girder tables, which we distinguish as through, semi-through and deck. The reason for these various designs is occasioned by the difficulty in many places of getting drainage from the pit to a sufficient depth to accommodate a deck table. These plate girder tables cost from $6,000 to $8,500, varying somewhat with local conditions, pertaining to the nature of foundations, etc. The labor amounts to from 35 to 40 per cent of the total cost.

3. We have none of this kind.

4. None.

5. None.

6. For plate girder tables, we use a concrete center pier, circle wall and circle rail foundation; the circle wall and foundation for circle rail being of monolithic construction. Piles are always used under center foundation, except at places where solid ledge rock is found. Piling is used under circle wall except where rock or other firm soil is found. We do not make it a practice to pave the pits. Drainage is provided by means of connection to roundhouse sewer or to low adjacent ground, according to local conditions.

7. We use gasoline and electric motors only for power; the electric motor, in our estimation, furnishes the ideal power for turntable operation where it can be procured without excessive cost. At several of our division points we have our own generators and consequently the current required for operating turntable costs but vey little.

I. O. Walker, Nashville, Chattanooga & St. Louis Ry.:

1. Our standard length is 70 ft.

2. Plate girder tables cost with ties, latches, etc., in place $3,200. Masonry and foundations, $2,000. The cost of the masonry is extremely variable however.

3. Our cast iron tables with Greenleaf centers are very old and I do not think the cost could be secured.

4. We have only one gallows frame turntable in use. This was purchased some eighteen years ago during the construction of one of the branch lines and has been moved four times and rebuilt twice; original cost unknown. It is an exceedingly unsatisfactory table.

5. The three designs mentioned above are all that we have in use. We are doing away with turntables wherever we can, substituting "Y's" in place of them, even when the cost of right of way is considerable.

6. Foundations depend upon local conditions.

7. We have no power operated turntables on our road, although we have arranged openings for air connections to motors if we decide to use them.

W. T. Main, Chicago & Northwestern Ry.:

1. Turntables newly installed in the future should be 80 ft. in length.

2. 70 ft. King Bridge Co., deck plate girder turntable installed at Chicago Ave., in 1907, cost as follows:

Material	$2,570.46
Labor	2,262.00
Total	$4,832.46

This table replaced an old 60-ft. deck plate girder and was installed under continuous traffic except for two days while new concrete center pier was allowed to set. Over 400 engines were turned every 24 hours on old table during construction of new circle wall, which will give some idea of conditions under which work was done and reason for high cost. Table is operated by 10 H. P. electric motor, which was used on an old table but furnished with new frame. Seventy-foot King Bridge Co., deck plate girder turntable installed in 1907 cost as follows:

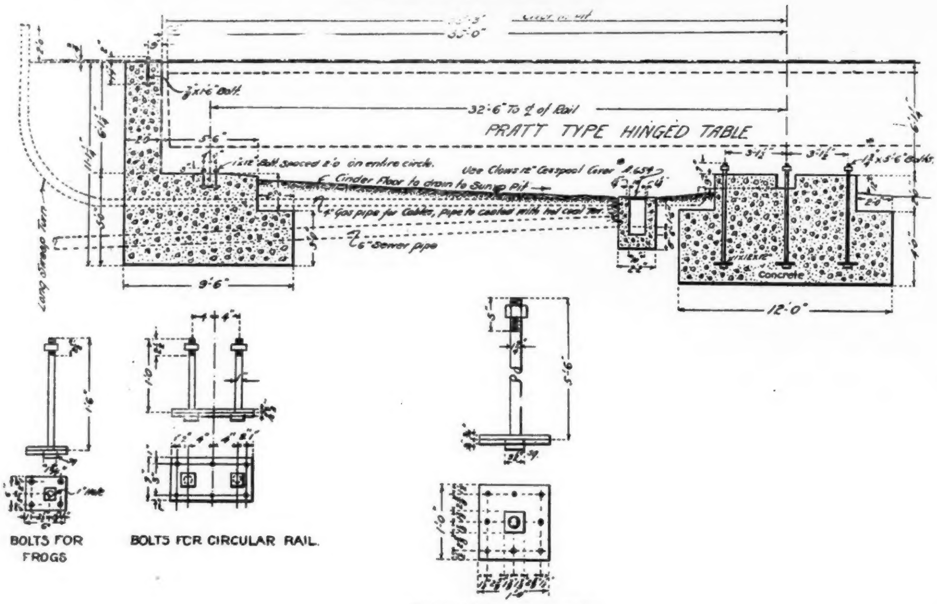
Material	$2,890.00
Labor	2,490.00
Total	$5,380.00

This table replaced an old 60-ft. Lassig plate girder and was installed under traffic in same manner as the old before mentioned. About $500 of the cost was due to renewal of radial tracks. The circle wall was built of concrete and the center pier of concrete, reinforced with scrap rails in order to spread the load over old masonry foundation. The table is operated by 10 H. P. Pilling air motor and has six reservoirs under runways, the air being furnished by air compressor.

3. Sixty-foot Stroebel deck plate girder table installed at Chicago Ave., in 1899, on old masonry wall and new center pier cost $2,520. Sixty-foot Greenleaf cast iron table installed at Milwaukee, 1899, including new center pier, cost $3,100; the table alone cost $1,160.

4. A 50-ft. gallows frame turntable installed at Evanston in 1896 with timber circle wall and center pier cost $983.

5. Do not use other kinds.



Chicago, Lake Shore & Eastern—70-ft. Pratt Type.

6. Circle walls should preferably be built of concrete except when table is renewed under traffic, where rubble masonry can be used to better advantage while working in cramped space. Center pier may require foundation unless subsoil is good where a spread foundation of concrete or masonry 12 ft. sq. will serve. The advantage of paving in pit will hardly justify the additional expense though it is easier to keep pit clean when paved and helps the drainage. The best drainage possible should always be secured. Circle walls should have an offset at one point to allow of examination and repairs to end rollers and boxes, particularly where table has rollers between girders. Masonry circle rail seat should be extended at two points, diametrically opposite, to afford support for jacks for raising table and examining center. This saves placing cribbing on soft ground when using jacks and renders the operation much safer.

7. Would recommend the use of electric motor for operating table wherever possible and where service demands the quick handling of engines; second choice, gasoline engine; third choice air motor. The latter gives excellent service, where there is plenty of time for handling engines and where there is sufficient supply of compressed air which can be piped to reservoirs, but it is slow in operation where engine to be turned must supply the air.

B. J. Sweatt, Contractor, Boone, Iowa:

1. For western railways using the larger type of locomotives, I do not consider that the length of table should be less than 75 ft., and 80 ft. would be preferable, where the tendency is to an increase in the length of locomotives and tenders.

2. In my opinion plate girder tables are the best for general use, the deck type being the most satisfactory and also the most economical where drainage of the pit is practical. The cost will, of course, depend on market value of iron, but will compare very favorably with any other type of table.

3. My experience with cast iron tables convinces me that they should never be used, except for lengths under 60 ft. and then only where the traffic is very light. All of the cast iron tables with which I have had anything to do had to be reinforced with heavy iron truss rods and even when so strengthened they were very unsatisfactory. I have no data on the cost of this type of table.

4. Gallows frame tables are, or at least they should be, relegated to the scrap heap by any railway that can afford an iron table.

5. No experience with other designs.

6. The foundation of a table is in my opinion very important; piles should be driven in all cases where solid rock, hard clay or cemented gravel is not found. The piles for center foundation should be spaced not more than 36 ins. apart and the number of piles should not be less than twenty. Concrete is about the best, and at the same time the cheapest material that can be found on which to rest the center casting. The depth of this should not be less than 4 ft. below the surface of the ground in the pit. The circle wall should have a good pile foundation made of concrete, stone or vitrified brick; extending at least 4 ft. below the surface of the pit. Turntable pits should always be paved, either with brick or an equal thickness of concrete.

Pit drainage is very important; the size of the drain should be not less than 6 ins. in diameter and it should have a fall of not less than 2 ins. in 100 ft. The inlet should be at a depth of 1 ft. below the lowest part of the pit and should be provided with a good cast iron grating.

In countries where there is liability of snow storms, it is economical to provide a cover for the entire pit; unless this is done the cost of operation will be excessive and the delays in turning the power will be many. This covering can be made in sections of 1-in. boards and supported on a light frame work of timber or iron in such a manner as to be easily removed when not required.

7. Where electric power can be obtained at a reasonable rate, an electric motor should be used, as it is not necessary to have an experienced man to run it and the cost of operating will be very small, as compared with the loss of time of roundhouse men, extra help and the saving of time in turning.

A. O. Cunningham, Wabash R. R.:

1. Not less than 75 ft.

2. Deck tables of this length cost $2,600.

3 and 4. These styles of tables are out of date and should not be considered.

5. Do not know of any other designs.

6. Foundation of circular wall and paving should always be of concrete; pits should be well drained; the cost of this for 75-ft. deck table would be $3,700.

7. Electricity is the ideal power for operating a table. If this cannot be obtained a gasoline engine may be employed of about 6 h. p. The cost of the electrical equipment would be $1,150, and for the gasoline engine equipment $1,000.

A. Montzheimer, Chicago, Lake Shore & Eastern Ry.:

There is no wood coping on the circle wall and no ties for the circle rail on a 70-ft. table recently installed at Gary, Ind., which we consider sufficient for all future requirements. We used 150-lb. rail for the circle. The table is of Pratt design, the girders being hinged at the center so that the end of the table take their share of the load. The table is turned by means of a 45 h. p. electric motor.

W. H. Moore, New York, New Haven & Hartford R. R.:

1. The standard length for turntables on our road is 75 ft., but we build some tables 80 ft. long.

2. The approximate average cost for a 75-ft. deck plate girder turntable is about $3,500, and for a half through plate girder turntable about $5,750.

3. We do not use cast iron tables.

4. We do not now build any gallows from tables except in rare instances for temporary use.

5. We use no designs except the plate girder type.

6. The cost of foundation of the circular wall, etc., varies so much, depending on the nature of the ground, that it would be hardly proper to name any average. I may say, however, that for a concrete pit with granolithic floor and granite center stone, in a location there was good firm sand requiring no piles and where drainage could be cheaply taken care of, the total cost is about $3,800.

7. For power operation we use monthly gasoline motors; some air motors, and electric motors where current can be conveniently obtained. The cost of power installation averages about $1,000.

G. Aldrich, New York, New Haven & Hartford R. R.:

1. For the requirements of modern engines, 75-ft. minimum; 80-ft. recommended.

2. (a) 75-ft. deck plate girder, erected complete, $3,600, base of rail on table to top of center pier, 6 ft. 4 ins.; base of rail on table to top of circular rail, 4 ft. 8 ins.

(b) 75-ft. through plate girder, cost with floor erected complete, $5,750; base of rail on table to top of center pier, 3 ft. 11 ins.; base of rail to top of circular rail, 2 ft. 9 ins.

3. Have not built any cast iron tables in the last 20 years.

4. Gallows frame tables built only for temporary use. Have no data as to cost.

5. The only designs we use are the plate girder tables.

6. The foundation, circular wall and center pier are constructed of concrete; the pit is usually paved with granolithic pavement. The cost varies in accordance with local conditions, ranging from $2,500 to $4,000.

7. For power we use:

(a) Air supplied by the engine being turned.
(b) Air supplied from compressors in adjacent shops.
(c) Gasoline engines.
(d) Electric motors.

Electric motors preferred where current is available; air motors supplied by compressors, second, and gasoline motors third choice.

The cost of power installation varies from $900 to $1,200.

C. F. Loweth, Chicago, Milwaukee & St. Paul Ry.:

Your inquiries are so general that they are difficult to answer. The proper length of table will depend on the character of the road; the grades, traffic conditions and the like will influence in the size of locomotives. For instance, on our Pacific Coast extension, west of the central portion of Montana, we are using 85-ft. tables, figuring that these will be of sufficient length to accommodate the Mallet type of locomotives, should we ever have occasion to use them on the several mountain divisions.

Between central Montana and the Missouri River we are using 80-ft. tables and the new ones on the old lines of our road are 75-ft.

The cost of tables you will readily appreciate will depend a great deal on the designs and capacities for which they are designed, and especially on the centers, where there is perhaps more than the usual variation in design and strength, and consequently cost.

N. F. Helmers, Northern Pacific Ry.:

1. The Northern Pacific Railway are installing 80- and 85-ft. tables. I do not anticipate any power in the future which will call for the use of a larger table.

2. An 80-ft. through table, without the circle rail, and weighing 114,855 lbs., cost in place, $4,600. Such a table was installed at Staples, Minn., with concrete circle wall and center foundation. The masonry was done by contract, and the installation of the table by the company at an expense of $3.92 per ton. The framing of ties and other timber cost $4.05 per thousand feet.

The cost was as follows:

	Labor.	Material.
Turntable	$211.44	$4,198.52
False work	......	12.93
Timber, ties planking, etc.	35.23	77.49
Painting	27.49	44.78
Total	$274.16	$4,333.72

Total cost (not including masonry), $4,607.88.

In 1908 an 80-foot table of the same type was installed at Minneapolis replacing one 64 feet in length. The foundation work was done under traffic, and the change of tables was done with a total interruption of 15 hours; itemized statement follows:

	Labor.	Material.
Excavation	$ 463.94	......
Gravel	92.14	......
Concrete work	408.28	$ 651.52
Forms	21.76	134.19
Circle rail	38.74	......
Table proper	261.36	4,040.95
False work for curbing	......	66.36
Removal of old brick curbing	104.42	......
Cleaning girders	37.98	......
Painting	23.76	21.04
Ties and coping	79.71	188.89
Engineering	......	14.66
Total	$1,632.09	$5,117.61

Total cost, $6,749.70.

3. We have no cast iron tables.

4. We do not use gallows frame tables.

5. We have no other designs.

6. I consider that ordinary conditions do not require the necessity of paving for the pit, but good drainage is essential in most cases.

7. For power we are using electricity and compressed air, while some of the 80 and 85-foot tables are being turned by hand.

Air motor in use at Jamestown, N. D., cost at St. Paul, $450; installation $19.81; total, $469.81.

Electric tractor furnished by Nichols & Bro., cost $1,104.37; installation, $115.86; total, $1,220.23.

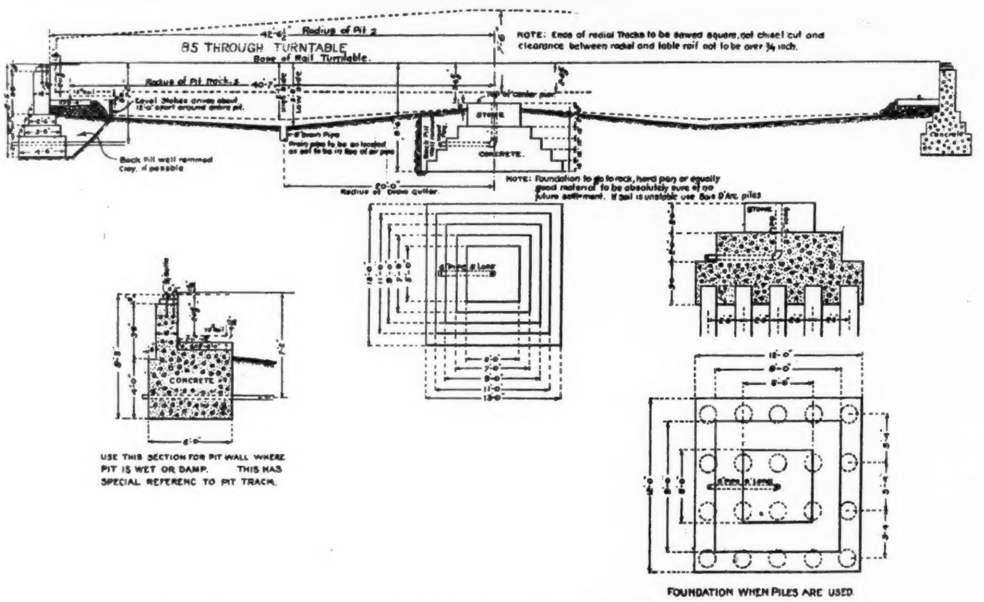
W. T. Powell, Colorado & Southern Ry.:

1. The up-to-date table should be 80 ft. long, with a capacity for turning 200-ton engines.

2. We installed recently an 80-ft. 200-ton through-plate girder table which cost as follows:

Table, f. o. b. Denver, including circle rails	$3,700.00
Material for concrete foundations and walls	1,090.00
Labor	1,600.00
Total cost	$6,390.00

This table replaced a 66-ft. table and we were compelled to excavate and put in the curbing under 42 tracks and keep them



Atchison, Topeka & Santa Fe—Standard Pit and Masonry for 85-ft. Turntable.

safe while in use. We drove 24 piles for center foundation and capped it with a block of concrete 12 ft. square and 4 ft. thick; a deck table of this length and capacity would cost about $600 less.

3. We have some cast iron tables, but have no records of cost.
4. None.
5. None.
6. We use concrete entirely for masonry; rails are fastened with bolts and cast clips, the bolts being set in the concrete; no paving; drained when necessary.

J. S. Browne, New York, New Haven & Hartford R. R.:

We have recently installed an 80-ft. table at Providence. The center pier is of concrete, reinforced with steel rails, on account of the irregularity of the supporting material, as it was feared that the concrete might be fractured by the load if laid without re-enforcement. The outer wall of the pit and the paving are also of concrete.

While an accurate record was not kept of the cost it was approximately as follows:

80-ft. steel table delivered at Providence	$3,400.00
Placing coping and circular rail and moving table into pit	800.00
Concrete in outer wall and center, including forms	2,800.00
Excavation, including disposal of material	1,500.00
Paving	300.00
Drain pipe to connect with sewer	200.00
Total	$9,000.00

The work was done by the company's force, and the high cost of excavation was due to the fact that a portion of the work was done in freezing weather, and it was necessary to handle the material more than once before its final disposal by work trains.

The table has not been equipped with power, but a gasoline engine will probably be attached later.

The company's standard main line turntable is 75 ft. long, but 80 ft. is consedered better at points where the largest type engines are turned, to permit of properly balancing them.

Deck plate girder tables are used where sufficient depth is available without excessive cost, but where this is not feasible, half through plate girder tables are used.

The superstructure of deck tables is about 30 per cent cheaper than that of half through tables, but this saving is balanced by the greater cost of the pit, so that under ordinary conditions the total cost of these two types is about equal.

Gasoline motors are generally used for power, although electric motors may be used to considerable extent in the future.

J. N. Penwell, Lake Erie & Western R. R.:

On our main line, we are taking out 62-ft. tables and replacing them with 80-ft. tables, using the old ones on the branch lines. We have two of the old cast iron tables, 50 ft. in length, which have been in use 20 years, one of which is in perfect condition and the other about worn out. We have only one of the old style gallows frame tables, but it is out of date and will be replaced with a more modern structure within two years. For the foundation and circle walls we are using concrete. If foundation is not absolutely reliable, we drive piles. Drainage is important and the very best should be provided. Our tables are all operated by hand, except one which we are now operating with air. Would recommend electricity wherever it can be had. In erecting new tables we make provision for air pipes in the foundation, so that we can use air in the future if we desire.

Inspection of Bridges and Buildings*

The committee sent out 64 letters asking for information on the subject and received 30 replies. Some very good information was received in this way and the committee desires to express its appreciation of the assistance rendered. Extracts from some of the letters are given at the end of this report.

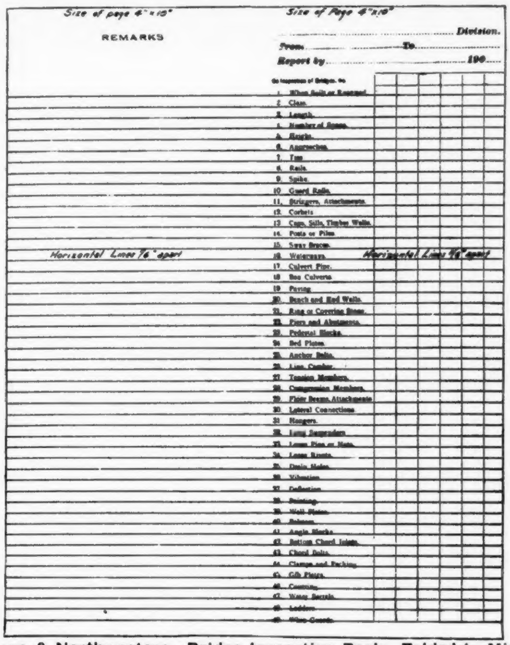
As stated in the subject, this report has to do both with the inspection of bridges and buildings.

INSPECTION OF BUILDINGS.

Very little information was received as to the method of inspection of buildings. The primary object of a railway plant is to produce transportation and the maintenance of bridges is more essential for this than is the maintenance of buildings. Hence the inspection of buildings does not get as much consideration as does the inspection of bridges. Wherever there is a railroad building there is a railroad employe to use it and he will note and report any necessary repairs or defects, if for no other reason than for his own convenience.

The bridge foreman is in and around the buildings in his district quite often and if he does the building work he will report the needed repairs from time to time.

*Report of committee (in part) of the American Railway Bridge and Building Association.



Chicago & Northwestern—Bridge Inspection Book—Folded in Middle and Bound.

As stated above, buildings are not essential for maintaining traffic, hence the inspection of them is quite different from that of bridges. On the usual building inspection the idea of rebuilding is seldom brought up. Even though a building is old, it can be repaired and will still serve its purpose just as well as any new building of the same type and size. The more important buildings are rebuilt in order to accommodate a larger volume of business than the old one was designed for, hence the new one is larger and better than the old one. In other words, buildings are inspected for maintenance of the present structure rather than for the necessity of rebuilding.

On some roads the building inspection is made at the same time as the annual bridge inspection. This system is all right where the buildings and bridges are maintained by the same department, but where the two departments are separate such a plan could not be followed, and each inspection would have to be made independent of the other. Quite often there is not time to make building inspections while the bridge inspection is being made, and it hardly seems necessary to make a special trip over the road for building inspection.

The division official in charge of the maintenance of buildings has sufficient opportunities to make inspection of buildings at different times during the year, while going over the road on other business than that of inspection. This, with the information sent in by the building foreman and the employes using the buildings, seems sufficient for building inspection.

Owing to the many different conditions at the various buildings, no practicable form can be made for inspection notes. An ordinary leather-bound field book would serve this purpose very well. Size of this book should be about 4½x7 ins., containing 100 leaves. To facilitate the making of sketches, the pages should have cross section ruling, the lines being spaced about 1-7 of an inch apart in both directions.

INSPECTION OF BRIDGES.

This subject has been treated quite extensively in the past by this Association and by the American Railway Engineering and Maintenance of Way Association. The proceedings of the thirteenth annual convention of this Association and volumes 5, 8 and 9 of the American Railway Engineering and Maintenance of Way Association contain reports on this subject. The report in volume 5 of the M. of W. Association is devoted to forms and blanks, for bridge inspection reports. Those in volumes 8 and 9 are devoted to methods of making inspections.

Bridge inspections can be classified into three kinds—current, general and special inspections.

CURRENT INSPECTIONS.

1. The section foreman while making his daily track inspection should also stop and examine all bridges and culverts. The object is to discover any broken or damaged parts which might have developed during the past 24 hours, due to storms, fires, derailments, etc.; no report need be made of this inspection unless something is found which impairs the safety of the bridge.

2. The bridge foreman should make bi-monthly inspection of all the bridges and culverts in his district. In this way he can keep in touch with the condition of the bridges and plan his work so as to do first that which is most needed. Owing to floods, derailments, fires or other causes which may have slightly damaged a bridge, it becomes necessary to make repairs not included in the yearly list of repairs. Such cases should be reported to the bridge foreman.

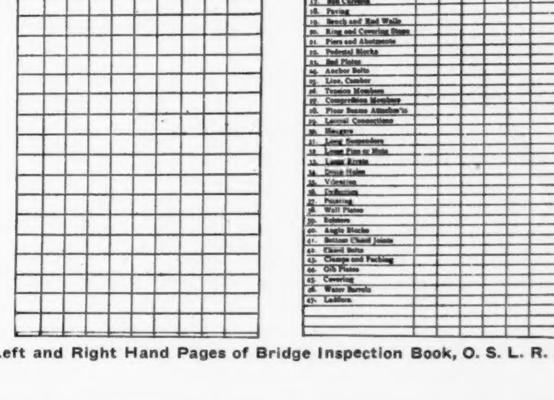
An ordinary blank book of convenient pocket size can be used for making notes on the inspection. Every night a report should be made out for each bridge inspected during that day. The current bridge inspection report used by the Central Railroad of New Jersey is very good for this purpose. It is practically the same as the form M. W. 1005 recommended by the M. of W. Association.

3. Reports from the foregoing current inspections will be received from time to time by the division foreman or supervisor. These will indicate to him which bridges need attention; he should then make inspection of such bridges and decide what shall be done to keep them in safe condition, making a report of the work necessary to his immediate superior, and he, in turn to the general official in charge of the maintenance of bridges. It would be of no advantage to use any special form for these reports and they should be made by letter.

GENERAL BRIDGE INSPECTION.

This might also be called the annual bridge inspection. It should be made annually and during this inspection all recommendations for repairs and renewals for the following year should be made. There should be on this inspection the general bridge inspector, division foreman, or superior, and the district foreman.

The general bridge inspector acts as a representative of the chief engineer and the engineer of bridges. He receives direct instructions from these men and should carry out their ideas



Left and Right Hand Pages of Bridge Inspection Book, O. S. L. R. R.

in making recommendations. This will also tend to give uniformity to the maintenance of bridges over the entire system.

The division foreman and the district foreman know the local conditions at each bridge, which are very important in determining what repairs should be made, or if the bridge should be rebuilt. The current of a stream may have some peculiar action and in case of a pile bridge there may be some difficulty in keeping it in line, or perhaps the bridge heaves in winter. These, and many other defects, cannot be discovered by an inspector going over the road, unless he happens to arrive at one of this class of bridges just when such defects are apparent.

The chief engineer or the bridge engineer may desire to investigate personally the more important items of rebuilding, in which case another inspection will be made by one or both of these men, accompanied by the bridge inspector, who will be prepared to give his reasons for the recommendation.

There should be a sufficient number of general bridge inspectors so that the entire system can be gone over during the time from May 1 to October 31. This applies to the roads in the north; in the south where the climate is favorable for bridge inspection the entire year the above time limits need not apply.

The notes of the general inspector should be kept in a book made for this purpose. Such books, samples of which were received by the committee, can be divided into three classes, noted below as A, B and C.

A. On one page the bridge number, class, length, number of repairs and height of four or five bridges is given in vertical columns at the top of the page. Just below this, on the same page, the different items which are to be considered at each bridge are indicated by means of horizontal headings. The opposite page has horizontal and vertical lines so that each pile, stringer or other part of a bridge will have a definite square in which its conditions can be noted. There is generally some code for making notes in such books.

The book used by the Oregon Short Line R. R. is an example of this class.

B. One page is the same as in class A, it being the page bearing the number and description of four or five bridges and the items to be considered. The other page is blank, except for the horizontal lines, to be used in making notes.

The book used by the Chicago and Northwestern Ry. is an example of this class.

C. The bridge number, class, length and height are given on one page, in a horizontal line. The other page has only horizontal lines or is divided into two vertical columns, one for the recommendation and the other for the bill of material.

The book used by the Santa Fe is an example of this class.

In the front part of all of these books instructions are given for making inspections.

Owing to the various types of bridges and culverts, and the different conditions found at each one, it is impossible to devise a ruled form for all cases by means of which notes can be made by filling in spaces and squares. Nor is it possible to devise a list of items to be examined which will apply to all types and conditions of bridges.

In the front of each book there should be instructions for making inspections. These will indicate in a general way how the notes are to be written and what is necessary in order to make a good inspection. On each page of the book there should be spaces for the general characteristics of the bridges, such as number, date, class, length and height; the remainder of the page should be left blank for the inspection notes. Each page should also have a heading showing the name of the division, date, name of the inspector and the stations between which the bridges on that page are. This form of a book will allow considerable freedom and such notes can be made as will apply to the bridge under construction.

The committee received numerous forms on which reports of general bridge inspections are made. Some of these forms are very elaborate, being divided into many columns, so that there is a small square for noting the condition of each part of the structure. The main part of the report is the recommendation for repairs or renewals and the largest part of the sheet should be devoted to this purpose, a small space being left for the bridge number, age, length and such general characteristics. In fact, there need be no special form for this report. In such case, instructions should be issued explaining how it should be made.

SPECIAL INSPECTIONS.

The general bridge inspector should have about five months of the year in which to make special inspections. In the northern country it is well to have this time in the winter, when he can get under the bridges on the ice. Another good time for special inspection is while a bridge is being painted, because then the inspector can use the staging swung by the painters.

These inspections are to include all the large bridges, especially the older ones, the object being to spend considerable time on each bridge and a very thorough inspection made. During the annual inspection all bridges should be noted that need such inspection.

Notes for these inspections should be kept in a leather-bound field book. All of the pages should be ruled, vertically and horizontally, so as to form square spaces 1-7 of an inch on a side. This ruling will aid in making sketches which are quite often necessary on these inspections.

Reports of these inspections can be written on a blank sheet, no special form being necessary.

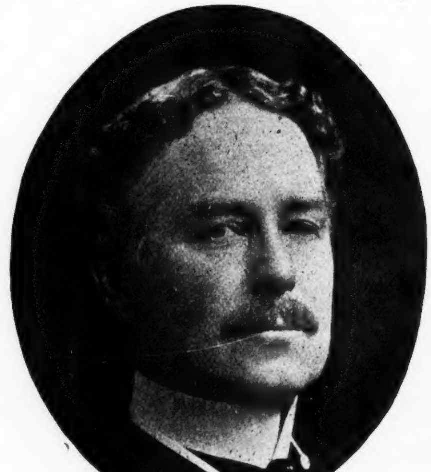
Personals

Mr. W. D. Taylor has been appointed chief engineer of the Minneapolis & St. Louis and the Iowa Central, with office at Chicago, Ill.

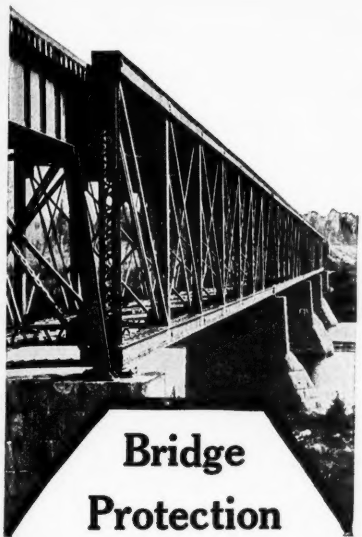
Mr. Irvin L. Simons has been appointed bridge engineer of the Chicago, Rock Island & Pacific, with office at Chicago, Ill.

Robert M. Burns

Robert M. Burns has been in the railway equipment business for the past six or seven years, previous to which time he spent twenty years in car construction. Thirteen years of this time was spent with the Pullman Car Co. in constructing cars under contract. After leaving this company he was connected with the Pressel Steel Car Co., having contracted to construct several thousand of the first steel underframe wooden cars that were placed in service. Mr. Burns is well known, being a member of a number of the Chicago clubs. He is very active in business, having a large clientele among the railroads and industrial companies.



Robert M. Burns.



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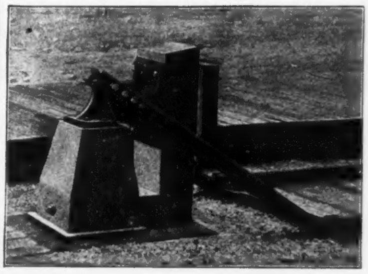

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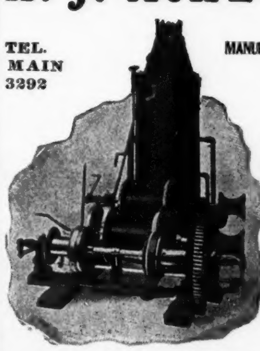

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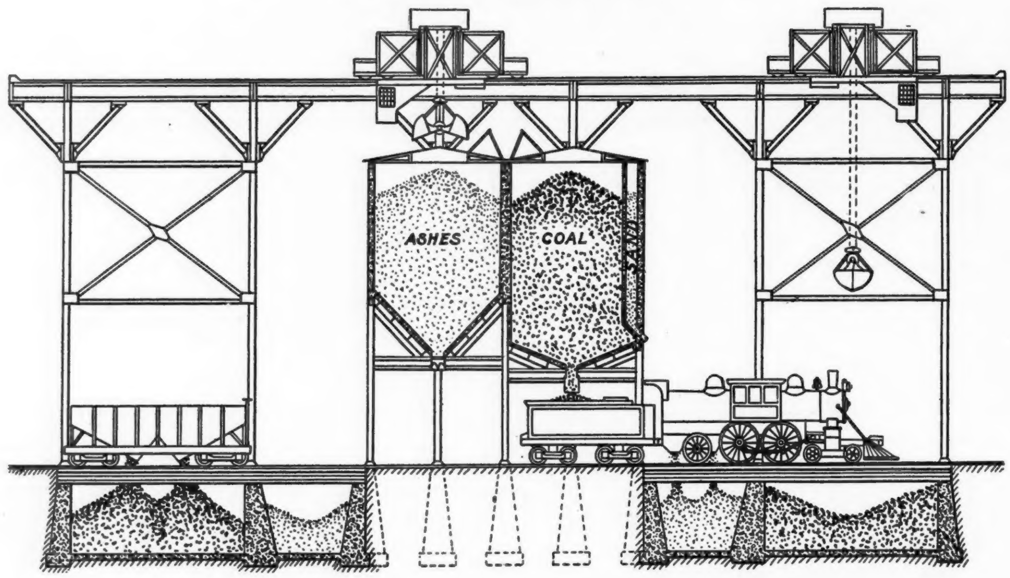

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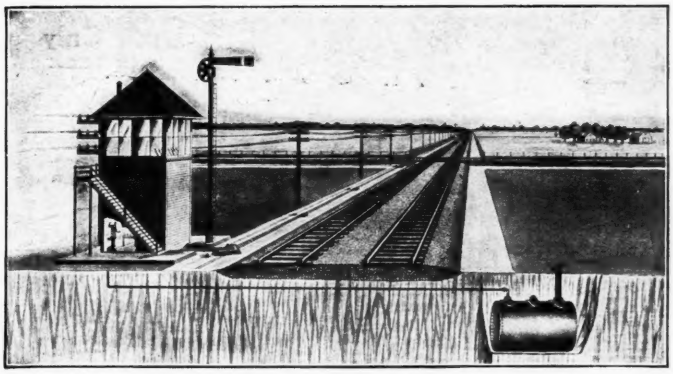

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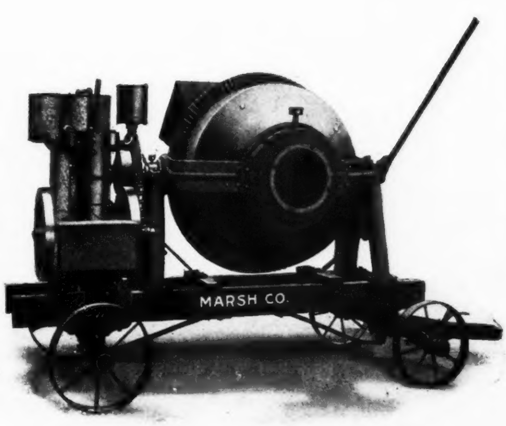

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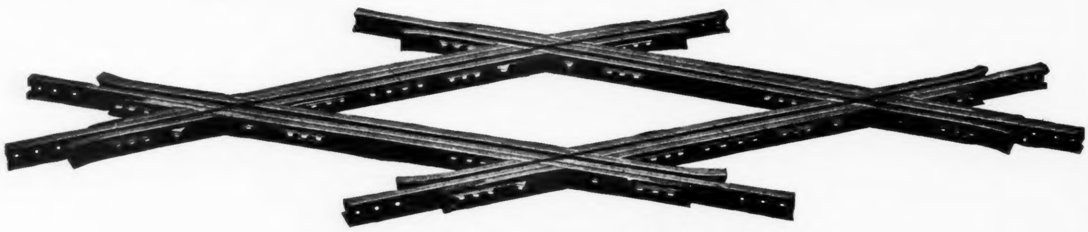

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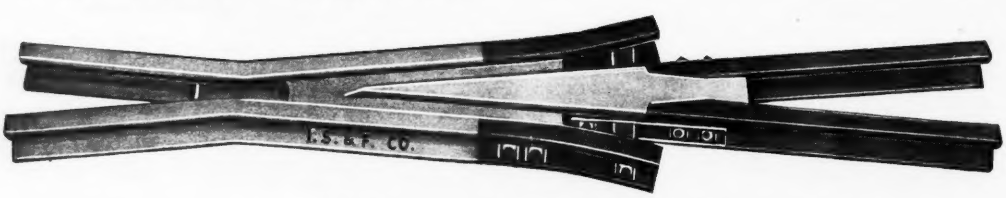

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